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Department of Agriculture

Forest Service

Northeastern Area
State & Private Forestry

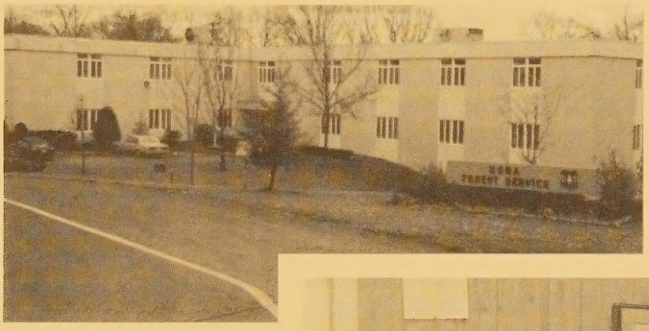
National Wood In Transportation Information Center

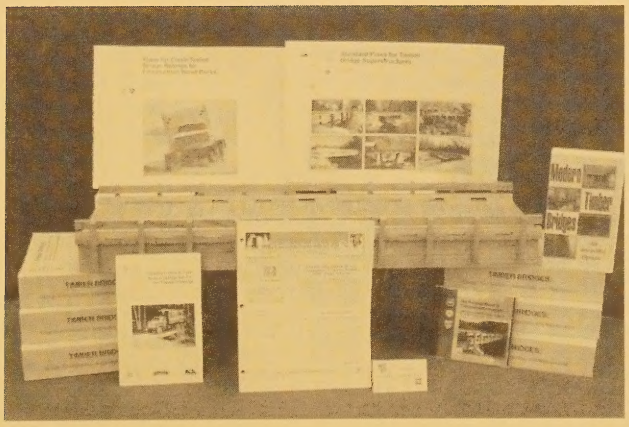
Morgantown, WV

NA-GR-01-97

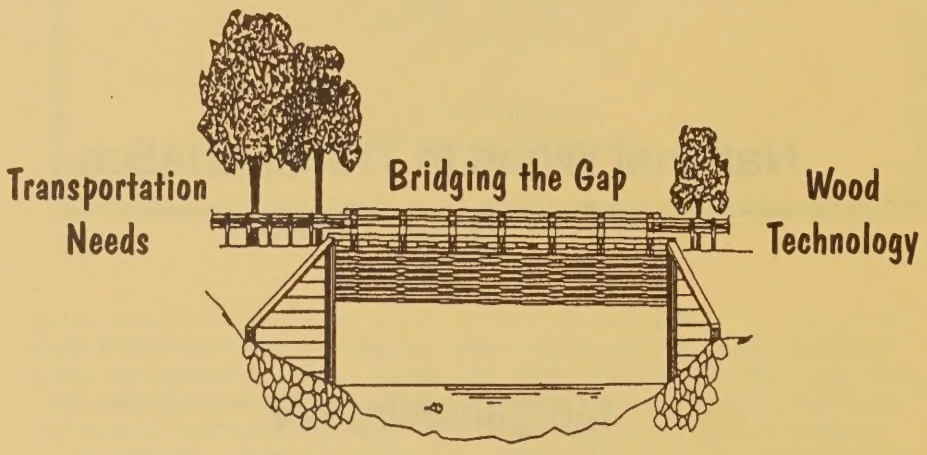
Wood In Transportation Publications List

A Guide to the Publications Available from the National Wood In Transportation Information Center - The Nation's Clearinghouse for Information about Wood In Transportation Applications





The
Wood In Transportation
Program



The Goal of WIT ...

- **Forest stewardship**
- **Economic vitality**
- **Revitalization**

... through a variety of transportation applications.

Table of Contents

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Introduction

The purpose of The Wood In Transportation Program is to improve the Nation's transportation infrastructure by using one of our most renewable resources, wood, for the construction of transportation structures such as:

- bridges
  - vehicular
  - portable
  - pedestrian and trail
- railway structures
- retaining walls
- box culverts
- sound barriers
- highway signs
- marine structures

The backbone of The Wood In Transportation (WIT) Program is technology transfer. Technical information on building vehicular and pedestrian bridges, portable bridges for temporary access, railway structures, and other transportation structures with timber has to be readily available and easy to understand.

The WIT Program's technology transfer activities are coordinated by the National Wood In Transportation Information Center (NWITIC) in Morgantown, West Virginia. The Center plays a vital role in fostering information sharing with highway officials, community leaders, and others across the Nation.

In its role as the Nation's clearinghouse for Wood In Transportation information, NWITIC has developed this publication list to inform interested individuals about the publications available from the Center. It includes a section labeled *"Additional Sources of Information"* which provides addresses and telephone numbers that may be used to obtain documents that cannot be issued by NWITIC. This listing will be updated on an as needed basis. New publications will be listed in the WIT Program's quarterly newsletter, *Crossings*.

You may request publications from this listing by marking your selections on the attached Publications Request Form. Please place an X in the box next to the code number of the publications you would like to receive. Fill out the name and address portion of the mailer as clearly as possible, and fold the request form in half. Tape the folded form shut so the NWITIC address is visible and return it to us. Postage is required. We will respond to your request as quickly as possible.

Edward T. Cesa
Program Coordinator
The Wood In Transportation Program

Section 01 — Wood In Transportation Program Information

Library ID: 01-0001

Title: **Wood In Transportation Program Annual Status Report**

Author: National Wood In Transportation Information Center (NWITIC) and Information Management and Analysis (IMA)

Publisher: USDA Forest Service, Northeastern Area, State and Private Forestry (NA-S&PF)

Year Published: 1999 Number of Pages: 13

The status report provides an overview of the Wood In Transportation program, program direction, and information about program components. In addition, the report provides summary tables pertaining to funding history, types of projects funded, and number of projects funded by state.

Library ID: 01-0002

Title: **Wood In Transportation Program Brochure**

Author: NWITIC and InS

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

The Wood In Transportation Program brochure is a short summary of the program concept, goals, objectives, including the roles of the National Wood In Transportation Information Center, the Forest Products Laboratory, the National Forest System, and the program coordinators. The brochure also provides regional and program headquarters contacts.

Library ID: 01-0003

Title: **Wood In Transportation Program Fact Sheet**

Author: NWITIC and InS

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

The Wood In Transportation Program Fact Sheet is a single sheet summary of the program goals, objectives, accomplishments, and an outlook for the future of the Wood In Transportation program.

Library ID: 01-0005

Title: **Wood In Transportation Project Application**

Author: NWITIC

Publisher: USDA Forest Service, NA-S&PF

Year Published: Annual Number of Pages: 27

The Wood In Transportation Project Application is the application package for the demonstration component of the program. The application explains what will be acceptable as projects, the focus of the demonstration program, the proposal format, and guidelines for submission of the proposal.

Library ID: 01-0006

Title: **National Timber Bridge Student Design Competition Information**

Author: SW Mississippi Resource Conservation and Development (RC&D), Inc.

Publisher: SW Mississippi RC&D, Inc.

Year Published: Annual Number of Pages: 2

URL: www.msrcd.org/bridge.htm

The National Timber Bridge Design Competition is open to student chapters of American Society of Civil Engineers and Forest Products Society. The competition's three main objectives are to promote interest in the use of wood as a competitive bridge construction material, to generate innovative and cost-effective timber bridge design techniques, and to develop an appreciation of the engineering capabilities of wood.

Library ID: 01-0007

Title: **Award Winning Timber Bridges**
Author: Various
Publisher: Various
Year Published: Varies Number of Pages: 8

This booklet shows and discusses award winning timber bridges.

Library ID: 01-0010

Title: **Modern Timber Bridges of West Virginia: Volume 1**
Author: Barry Dickson, Constructed Facilities Center, (CFC) West Virginia University (WVU)
Publisher: CFC, WVU
Year Published: 1995 Number of Pages: 53

Modern Timber Bridges of West Virginia consists of two volumes. Volume I is intended for the general public and includes photographs, maps and general information on each bridge. Volume II includes case studies of the four types of new timber bridges built in West Virginia, followed by data sheets for each of the 53 new bridges built between 1989 and 1994.

Library ID: 01-0011

Title: **Modern Timber Bridges in West Virginia: Volume 2**
Author: Barry Dickson, CFC, WVU
Publisher: CFC, WVU
Year Published: 1995 Number of Pages: 82

This publication was prepared to provide an introduction to West Virginia's new timber bridges to engineers, decision makers, and the general public. The history of stress-laminated bridges is still brief and much information regarding the long-term performance has yet to be gathered.

Library ID: 01-0018

Title: **Wood In Transportation Program - Special Projects, Fiscal Years 1989 through 1997**
Author: NWITIC and InS
Publisher: USDA Forest Service, NA-S&PF
Year Published: 1998 Number of Pages: 87

This report contains information on special reports for the fiscal years 1989 through 1997.

Library ID: 01-0019

Title: **Proceedings of the National Conference on Wood Transportation Structures**
Author: Forest Products Laboratory (FPL)
Publisher: USDA Forest Service, FPL
Year Published: 1996 Number of Pages: 494
URL: http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr94.htm

The Federal Highway Administration and the USDA Forest Service, Forest Products Laboratory, jointly sponsored the National Conference on Wood Transportation Structures, October 23-25, 1996, in Madison, Wisconsin. This was a direct result of 5 years of cooperation in conducting research related to timber transportation structures. The objective of the conference was to present state-of-the-art information on wood utilization in transportation applications. The conference included a plenary session, reviewing timber bridges throughout the world, followed by concurrent paper sessions on various topics. This report includes the papers presented at this conference.

Library ID: 01-0020

Title: **The Federal Highway Administration's Highway Timber Bridge Research and Demonstration Program, Status Report 1996**

Author: USDOT FHwA
Publisher: USDOT FHwA
Year Published: 1996 Number of Pages: 15

The Federal Highway Administration (FHwA), as directed under Section 1.039 of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 is implementing the Highway Timber Bridge Research and Demonstration Program. Funding for the program is available over the 6-year life of the ISTEA legislation. The program, in its fifth year of funding, is being coordinated between the FHA's Office of Engineers, the Office of Engineering Research and Development, and the Office of Technology Applications. The preliminary report presents the status of the timber bridge program.

Library ID: 01-0021

Title: **Wood In Transportation Plan of Work**
Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: Annual Number of Pages: 24

This report contains the 1998 fiscal year plan of work. The appendix lists demonstration projects and transfers.

Library ID: 01-0022

Title: **Wood In Transportation Fact Sheet, Stress-Laminated Modern Timber Bridges**
Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: 1996 Number of Pages: 2

Interest in timber bridges has increased significantly in recent years primarily as a result of programs implemented through the Wood in Transportation Program (formerly the National Timber Bridge Initiative). During the seven years of the Initiative, many versions of existing and new design have been demonstrated. This fact sheet on stress-laminated southern pine bridges has evolved during the initial years of the Program. We believe the stress-laminated design, as illustrated, is most structurally and economically suited for spans of 10 to 20 feet. These bridges provide a valuable option for replacing bridge structures lost during a natural disaster.

Library ID: 01-0024

Title: **National Wood In Transportation Information Center's Annual Technology Transfer Report**
Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: Annual Number of Pages: 4

The fiscal year technology transfer report summarizes requests for information received at the National Wood In Transportation Information Center, located in Morgantown, WV. The fiscal year runs from October 1 through September 30.

Library ID: 01-0026

Title: **Salt Storage Facility, Cedar County, IA: Special Project Fiscal Year 1995**
Author: Kasey Russell
Publisher: NWITIC
Year Published: 1998 Number of Pages: 5

In 1996, the Limestone Bluffs Resource Conservation and Development Area and the Cedar County engineering staff hired a contractor to build a salt storage facility in Cedar County, Iowa. Several vehicular bridges have been constructed with cottonwood; but, one goal of this project was to see if cottonwood, which is native to Iowa, had additional uses in the Iowa transportation system.

Library ID: 01-0027

Title: **Wood In Transportation Program Website Brochure**

Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: 1999 Number of Pages: 2

WIT Website Brochure provides an overview of the features available over the Internet. These features include information about WIT Publications, WIT Grants, WIT Events, WIT Links, and WIT Program Coordinators. The Brochure also briefly describes the USDA Forest Products Laboratory's Wood In Transportation Website.

Library ID: 01-0031

Title: **Wood In Transportation Bookmark**

Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: 2001 Number of Pages: 2

Program bookmark that highlights the WIT website.

Library ID: 01-0033

Title: **Special Project Application**

Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: Annual Number of Pages: 13

Special project application form for the National Wood In Transportation Program. Maximum Forest Service funding for a special project is $30,000.

Library ID: 01-0034

Title: **Final Report Guidelines for Wood In Transportation Projects**

Author: NWITIC
Publisher: USDA Forest Service, NA-S&PF
Year Published: Annual Number of Pages: 9

Final report guidelines for cooperators that have completed Wood In Transportation projects.

Library ID: 01-0035

Title: **National Wood In Transportation Program's CD-ROM**

Author: Various
Publisher: USDA Forest Service, FPL
Year Published: 2001 Number of Pages: NA

CD-ROM that includes WIT documents in electronic format. Documents include the timber bridge manual, various standard drawings, fact sheets, Crossings newsletters, research reports, etc.

Library ID: 01-0036

Title: **Wood In Transportation Program: An Overview**

Author: Sheila Rimal Duwadi, Michael A. Ritter, Edward Cesa
Publisher: Transportation Research Board
Year Published: 2000 Number of Pages: 6
URL: http://www.fpl.fs.fed.us/documnts/pdf2000/duwad00a.pdf

Section 01 — Wood In Transportation Program Information *cont.*

Library ID: 01-0036 *cont.*

Research and demonstration bridge projects to further develop wood for transportation structures increased substantially in the United States in 1988 under a legislative action by the U.S. Congress known as the Timber Bridge Initiative. This program, renamed the Wood In Transportation Program, continues today and is administered by the Forest Service. The Federal Highway Administration (FHwA) became involved in timber bridge research in 1990. The FHwA program increased substantially under the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). From 1992 to 1997, ISTEA authorized significant funding for timber bridge research, technology transfer, and demonstration bridges. The current transportation authorization, the Transportation Equity Act for the 21st Century, does not contain a program for timber bridges similar to that of ISTEA; however, there are provisions under the fiscal year 1999 Transportation Appropriations Bill for advancing engineered wood and composites technology through research and demonstration projects to further develop the use of wood for transportation structures. As a result of these combined efforts, a large number of research projects have been initiated, and a number of demonstration bridges have been built under both programs. An overview of the research and the demonstration timber bridge programs is provided here.

Library ID: 01-0037

Title: **Commercializing Proven Technology Through the USDA Forest Service Wood In Transportation Program**

Author: Edward T. Cesa, Merv Eriksson, Edward Tice, Janet L. Lemon

Publisher: IABSE Conference: Innovative Wooden Structures and Bridges

Year Published: 2001 Number of Pages: 6

A significant opportunity exists in the United States to improve local transportation networks and to assist in revitalizing local economies by using wood for bridges and other transportation structures. To address this issue, the United States Congress provided funding to the USDA Forest Service in 1989 for a National Timber Bridge Initiative. The program is now called Wood In Transportation. The program has three key components: (1) Demonstration Projects, (2) Research, and (3) Technology Transfer and Information. In 1996, the program redirected its demonstration project activities to fully focus on economy of scales and structural adequacy of demonstration structures. This paper highlights three demonstration "commercialization" projects, each resulting in the construction of three or more bridges. Project cooperators believe that these types of projects were more effective than single projects because they learned how to improve the process each time another bridge was designed and built.

Section 02 — Design and Bridge Plans

Library ID: 02-0001

Title: **Timber Bridges: Design, Construction, Inspection and Maintenance**

Author: Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1992 Number of Pages: 950

This manual describes the design, construction, inspection and maintenance for bridges manufactured from wood.

Library ID: 02-0002

Title: **Standard Plans for Southern Pine Bridges**

Author: Paula D. Hilbrich Lee, Michael A. Ritter, Michael Triche

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 26

URL: http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr84.pdf

The development of standardized timber bridge plans and specifications is a key element in improving design and construction practices. The bridge plans presented were developed as a cooperative effort between the USDA Forest Service, Forest Products Laboratory (FPL); the University of Alabama; and the Southern Pine Council and are the first step in developing standardized designs for the southern United States where Southern Pine is the primary structural wood species group. This publication contains standardized designs and details for three timber bridge superstructure types, including stress-laminated timber (glulam) bridges, and longitudinal sawn lumber stringer bridges with transverse plank decks. Each set of plans encompasses numerous span length and width combinations, design loading for AASHTO HS 20-44 and HS 25-44 vehicles, and two options for live-load deflection criteria.

Library ID: 02-0003

Title: **Plans for Crash-Tested Bridge Railings for Longitudinal Wood Decks**
Author: Michael A. Ritter, Ronald K. Faller, Paula D. Hilbrich Lee, Barry T. Rosson, Sheila Rimal Duwadi
Publisher: USDA Forest Service, FPL
Year Published: 1995 Number of Pages: 27

In the past decade, bridge railing design criteria have moved away from static-load design and have focused on full-scale crash testing as a more appropriate and reliable means of evaluating bridge railings. The five bridge railing plans presented reflect the results of a cooperative research project between the Midwest Roadside Safety Facility, University of Nebraska-Lincoln; the USDA Forest Service, Forest Products Laboratory; and the Federal Highway Administration. The project objective was to develop and crash test railings and approach railing transitions for longitudinal wood bridge decks. The bridge railings were completed in accordance with AASHTO Performance Level 1, Performance Level 2, and NCHRP Report 350 Test Level 4 (TL-4). Approach railings were tested or adapted from previous testing in accordance with NCHRP Report 230. Full drawing sets are provided in customary U.S. and SI units of measure. The testing procedures, results, and drawings have been approved by the Federal Highway Administration Federal-Aid and Design Office for use on Federal-aid highway projects.

Library ID: 02-0004

Title: **Design, Construction, and Quality Control Guidelines for Stress-Laminated Timber Bridge Decks**
Author: J. F. Davalos, S. H. Petro
Publisher: USDOT FHwA
Year Published: 1993 Number of Pages: 58

Under the U. S. National Timber Bridge Initiative Program, sponsored by Congress in 1989 and administered by the United States Department of Agriculture, Forest Service, approximately 130 modern timber bridges are currently in service in 41 participating States. Most of these bridges use stress-laminating technology. Considerable research on stress-laminating technology has been completed in the USA and has provided design, construction, and inspection guidelines for timber bridge decks. Guidelines for the design of stress-laminated timber decks have been published by AASHTO, but they do not provide comprehensive information on materials, construction, and inspection. Therefore, this document presents: (1) background information on timber bridge materials and their quality control; (2) a comprehensive step-by-step design procedure based on the 1991 AASHTO Guide Specification; and (3) guidelines for and an inspection checklist is included. This publication is part of a collection of three booklets of the study "Education and Technology Transfer," under the Timber Bridge Research Program. The other two booklets are: FHWA-RD-92-044 Corrosion Protection of Steel Hardware Used in Modern Timber Bridges, FHWA-RD-93-024 Timber Substructures for Bridge Applications.

Library ID: 02-0005

Title: **Materials for and Design of Hardwood Glulam Bridges**
Author: Harvey B. Manbeck, Keith Shaffer
Publisher: USDA Forest Service, NA-S&PF
Year Published: 1994 Number of Pages: 57

This publication presents design requirements, calculations, and details for 30 to 40 feet simply supported hardwood glulam girder bridges with transverse glulam decks. The new hardwood glulam bridge standards being prepared for PennDOT are discussed. The design procedures are explained and are followed by design examples.

Library ID: 02-0006

Title: **Engineered Composite Bridge Plans**
Author: Trus Joist MacMillan
Publisher: Trus Joist MacMillan
Year Published: 1995 Number of Pages: 6

Parallam PSL bridges offer solutions for today's short-span bridge projects. Advances in engineered timber materials, bridge design and component fabrication allow for bridge projects that cost less, save time, require minimal maintenance and provide long-lasting quality and beauty.

Library ID: 02-0008

Title: **Using Lightweight Metal Plate Connector Wood Trusses in Bridges**
Author: H. Dagher, V. Caccese, F. Altimore, Y Hsu, R. Wolfe, M. Ritter
Publisher: American Society of Civil Engineers
Year Published: 1995 Number of Pages: 4

Lightweight Metal Plate Connector (MPC) wood trusses offer advantages for short span rural bridges such as ease of construction, high stiffness, and wide availability. It is shown that these trusses may be used in bridge applications provided that proper design for fatigue of the MPC joints, proper corrosion protection, and proper details to prevent MPC back-out are incorporated into the design. Recommendations for fatigue design are given. Two MPC truss bridges, one 14.0 m (46 ft) long and the other 11.8 m (39 ft) long built in Maine in 1993 and 1994 are briefly described.

Library ID: 02-0009

Title: **Vermont/New Hampshire Timber Retaining Wall Design Package**
Author: North Country RC&D
Publisher: North Country RC&D
Year Published: 1994 Number of Pages: 7

Timber, a renewable resource, is an excellent proven choice for your retaining wall project. This paper provides information on: history and application; application and overview; explanation of plans and how to use them; disclaimer; general notes; decision trees; timber schedules; and construction sequence.

Library ID: 02-0010

Title: **Field Performance of Timber Bridges: 2. Cooper Creek Stress-Laminated Deck Bridge, Design, Construction and Evaluation of Timber Bridge Constructed of Cottonwood Lumber**
Author: Michael A. Ritter, James P. Wacker, Everett P. Tice
Publisher: USDA Forest Service, FPL
Year Published: 1995 Number of Pages: 30

The Cooper Creek bridge was constructed in February 1992, in Centerville, Iowa. The bridge is a two-span, continuous stress-laminated deck structure 42-ft long and approximately 26.5-ft wide. The bridge is unique in that it is one of the first known stress-laminated timber bridge applications to use eastern cottonwood. The performance of the bridge was monitored continuously for 28 months beginning at the time of installation. Performance monitoring involved gathering and evaluating data relative to the moisture content of the wood deck, force level of the stressing bars, vertical creep, and behavior of the bridge under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well with no structural or serviceability deficiencies.

Library ID: 02-0011

Title: **Portable Glulam Timber Bridge Design for Low-Volume Forest Roads**
Author: S. E. Taylor, K. P. Keliher, J. D. Thompson, M.A. Ritter, G. L. Murphy
Publisher: National Academy Press
Year Published: 1995 Number of Pages: 12

This Technical Release describes the use of portable timber bridges on forest roads.

Library ID: 02-0012

Title: **Timber Box Culverts - Plans, Timber Substructures for Bridge Applications**
Author: J. F. Davalo, S. H. Petro
Publisher: USDOT FHwA
Year Published: 1994 Number of Pages: 111

Library ID: 02-0012 *cont.*

Timber Bridges have become a viable alternative for new bridge construction on low-volume roads, where it is imperative that the bridges be economical and long-lasting. Considerable research on superstructural systems has been completed in the U. S., has provided design of stress-laminated timber decks, and have been published by AASHTO. However, practical recommendations concerning timber substructural systems are not readily available. Therefore, the objectives of these booklet are: (1) to present background information on timber substructures, (2) to present practical design guidelines for various systems, and (3) to present sources of additional information. The following six systems were selected: timber piles, steel bent-pile abutments, culverts, crib-wall abutments, and stub abutments. This publication is part of a collection of three booklets for the study "Education and Technology Transfer," under the Timber Bridge Research Program. The other two booklets are: FHWA-RD- 92-044 Corrosion Protection of Steel Hardware used in modern Timber Bridges, FHWA-RD-91-120 Design, Construction, and Quality Guidelines for Stress-Laminated Timber Bridge Decks.

Library ID: 02-0013

Title: **Smith Rapids Covered Bridge Plan, Chequamegon National Forest, Price County, WI**

Author: Art Johnson

Publisher: USDA Forest Service, National Forest System (NFS)

Year Published: 1990 Number of Pages: 8

This paper provides design plans for the Smith Rapids Covered Bridge including list of materials, site map, views and laterals, deck and truss, rafter details, truss joint details, approach railings, and abutments.

Library ID: 02-0018

Title: **Designing Timber Bridges for Long Life**

Author: Frank W. Muchmore

Publisher: USDA Forest Service, NFS

Year Published: 1986 Number of Pages: 15

Wood is marvelously adaptable structural building material. When treated with a compatible preservative to prevent early decay deterioration, it is an economical and practical structural material for many short-span bridges (spans in the range of 15 - 60 feet). Timber's ineptness to deicing chemicals, as well as some new design developments, such as glued-laminated deck panels and prestressed structures. Important factors in assuring long, useful lives for timber bridges are: designing to avoid water-trapping details, use of effective and compatible preservative treatment, and following a systematic inspection and maintenance program. Attention to these factors will provide a life span competitive with other structural materials, such as steel and concrete, and will, in most cases, dramatically increase the useful life of timber bridges.

Library ID: 02-0020

Title: **Stress-Laminated Timber Deck Bridges: Prototype Project 1988**

Author: Michael G. Oliva; Michael Ritter; Al G. Dimakis

Publisher: Forest Products Research Society

Year Published: 1988 Number of Pages: 6

This paper presents a brief overview of the concept and development of stress laminating for timber highway bridge decks and describes a series of prototype concept of using prestressing to laminate timbers or trusses to form a bridge is described along with the developmental research leading to the use of the system. Advantages and use limitations for the system are noted and compared to other types of bridge systems. The remainder of the paper is dedicated to describing a series of bridges which have been erected and instrumental in the United States and performance data from those bridges.

Library ID: 02-0021

Title: **Performance Level 1 Bridge Railings for Timber Decks**

Author: Ronald K. Faller; Michael A. Ritter; James C. Holloway; Brian G. Pfeifer; Barry T. Rosson

Publisher: USDA Forest Service, FPL

Year Published: 1992 Number of Pages: 36

Library ID: **02-0021 *cont.***

Historically, very little research has been conducted for developing crashworthy railing systems for timber bridge decks. For timber to be a viable material in the new construction of bridges, vehicular railing systems must be developed and crash tested. The USDA Forest Service, Forest Products Laboratory, in conjunction with the Midwest Roadside Safety Facility, undertook the task of developing and testing three bridge railings - two glulam timber railing systems and one steel railing system - for use with longitudinal timber bridge decks. This research effort provided a variety of aesthetically pleasing and /or economical bridge railing systems for timber decks. As part of the project, a series of four full-scale crash tests were conducted on the bridge railing designs. The tests were conducted according to the performance level 1 (PL-1) specified in the American Association of State Highway and Transportation Officials' Guide Specifications for Bridge Railings (1989). The safety performance of each of the three bridge railings was acceptable according to the PL-1 guide specifications.

Library ID: 02-0025

Title: **Procedure for Design of Glued-Laminated Orthotropic Bridge Decks**
Author: William J. McCutcheon, Roger L Tuomi
Publisher: USDA Forest Service, FPL
Year Published: 1973 Number of Pages: 42

The most recent improvement in timber bridge design is the vertically glued-laminated panel deck, with the panels placed in a transverse direction to the stringers. Experimental evaluations showed its performance to be superior to that of the conventional nailed-laminated deck. Design methods which consider the glued-laminated deck as a orthotropic plate accurately predict its behavior. Since a laminated bridge deck is constructed from many relatively narrow panels, it is necessary to install connectors, which allow the deck to act as a continuous plate. Eight different connector systems were evaluated and steel dowels are best suited for the purpose. Design criteria for dowel connectors, based on the theory of a beam supported on an elastic wood foundation, were developed. The problem of dimensional stability was investigated by observing the behavior of glued-laminated panels at a long-term exposure site, and by observing bridges that have been in service for several years. It was found that creosote treatment greatly retards changes in moisture content and associated dimensional changes. The design procedures for glued-laminated transverse decks and steel dowel connectors are presented as a set of easy-to-use graphs and tables. These should be of immediate use for designers of timber bridges.

Library ID: 02-0026

Title: **Simplified Design Procedure for Glued-Laminated Bridge Decks**
Author: W.J. McCutcheon, R.L. Tuomi
Publisher: USDA Forest Service, FPL
Year Published: 1974 Number of Pages: 8

Procedures have recently been developed for the design of glued-laminated bridge decks and for steel dowel connectors. However, since most bridges are designed in accordance with the Specifications of the American Association of State Highway Officials (AASHO), which consider only three different distributions of wheel load, the original design curves have been reduced here to even simpler equation form. Equations can be used when designing decks for AASHO H10, H15, and H20 trucks. These equations make it easy and fast for the bridge designer to compute moments and shears in glued-laminated decks.

Library ID: 02-0027

Title: **Wood Highway Noise Barrier Specifications**
Author: National Forest Products Association (NFPA) Staff
Publisher: NFPA
Year Published: 1981 Number of Pages: 6

This presentation provides specifications for design using: posts (solid sawn); glued laminated timber; planks and boards; and plywood. It includes grademarking and certification, and pressure preservative treatment.

Library ID: 02-0028

Title: **Erection Procedure for Glued-Laminated Timber Bridge Decks with Dowel Connectors**
Author: Roger L. Tuomi
Publisher: USDA Forest Service, FPL
Year Published: 1976 Number of Pages: 15

Timber bridges are widely used in rural areas and on Forest Service roads. They are durable, economically attractive, and can be erected with a minimum of skilled labor and equipment. The newly developed glued-laminated bridge deck provides excellent structural performance, and promises to extend the service life of the bridge by protecting the superstructure. Unfortunately, few crews have had experience in erecting bridges with this system, and often common mistakes are made that can cause difficulties. Through the experience gained on eight different bridge jobs, an efficient, workable erection procedure has been developed. The erection sequence and procedures are presented in this research paper, and suggestions made to avoid common pitfalls. These guidelines should help an erection crew build a timber bridge with minimal difficulty.

Library ID: 02-0029

Title: **Design Procedure for Glued-Laminated Bridge Decks**
Author: Roger L. Tuomi, William J. McCutcheon
Publisher: USDA Forest Service, FPL
Year Published: 1972 Number of Pages: 8

The most recent advance in timber bridge construction is the glued-laminated deck. Experimental evaluations have shown its performance to be superior to that of a nailed-laminated deck, and new design criteria are therefore needed which take into account this superiority. By considering the glued to be an orthotropic plate, it is possible to accurately predict its behavior. The results have been presented as a set of graphs, which can be used easily by bridge designers. It is estimated that glued-laminated decks will be used in widths of about 4 feet. Therefore, connectors are needed to tie the individual deck segments together. Steel dowels have been shown to be well suited to this purpose, and criteria for their design have also been developed.

Library ID: 02-0032

Title: **Innovations in Glulam Timber Bridge Design**
Author: Michael A. Ritter , Thomas G. Williamson, Russell C. Moody
Publisher: American Society of Civil Engineers
Year Published: 1994 Number of Pages: 6

Structural glued-laminated timber has been successfully used as a bridge material in the United States for more than 50 years. Until the late 1980s, the majority of these bridges were conventional girder or deck superstructures manufactured from softwood lumber species. Recently, applications employing glued laminated timber have been expanded to include alternative wood species and new designs utilizing the concept of stress-laminating. Additionally, current research on the composite materials using glulam may lead to future applications for timber bridges.

Library ID: 02-0033

Title: **LRFD Provisions for Wood Bridges**
Author: Michael A. Ritter, Andrzej S. Nowak
Publisher: American Society of Civil Engineers
Year Published: 1994 Number of Pages: 6

A project to develop a load and resistance factor design (LRFD) edition of the American Association of State Highway and Transportation Officials (AASHTO) Standard Specifications for Highway Bridges is complete. A part of this effort involved the development of LRFD provisions for wood bridges. These new specifications include numerous changes and several significant departures from current allowable stress design practices for wood bridges.

Library ID: 02-0035

Title: **Design and Evaluation of Two Bridge Railings for Low-Volume Roads**
Author: Ronald K. Faller, Barry T. Rosson, Dean L. Sicking, Michael A. Ritter, Steve Bunnell
Publisher: National Academy Press
Year Published: 1995 Number of Pages: 16

The U.S. Department of Agriculture (USDA) Forest Service, Forest Products Laboratory (FPL), and Headquarters Engineering Staff, in cooperation with the Midwest Roadside Safety Facility undertook the task of developing bridge railing systems for roads with low traffic volumes and low speeds. Two low-cost bridge railing systems were developed and successful full-crash tests were conducted for their use on timber bridge decks using longitudinal lumber laminations. This paper provides design and evaluation of two bridge railings for low-volume roads.

Library ID: 02-0036

Title: **Load and Resistance Factor Design Code for Wood Bridges**
Author: Andrzej S. Nowak, Michael A. Ritter
Publisher: National Academy Press
Year Published: 1995 Number of Pages: 7

The development of a load and resistance factor design (LRFD) edition of AASHTO's Standard Specifications for Highway Bridges is complete. A part of this effort involved the development of LRFD provisions for wood bridges. These new specifications include numerous changes and several significant departures from current allowable stress design practices for wood bridges.

Library ID: 02-0037

Title: **State of the Art Report: Glulam Timber Bridge Design in the U.S.**
Author: M.A. Ritter, T.G. Williamson
Publisher: Universitat Karlsuhe
Year Published: 1995 Number of Pages: 11

This report presents a look at glued-laminated timber successfully used as a highway bridge material. It also explains the history and deals with current research being done.

Library ID: 02-0038

Title: **Portable Timber Bridges: An Eco-friendly Solution for Stream Crossings**
Author: Kasey Russell
Publisher: USDA Forest Service, NA-S&PF
Year Published: 1997 Number of Pages: 8
URL: http://www.fs.fed.us/na/wit/pdf/portab~1.pdf

The goal of the project was to design and build several experimental portable timber bridges that are relatively easy to manufacture, transport, and install. They are used for temporary access during harvesting operations.

Library ID: 02-0039

Title: **Recommended Construction Practices for Stress-Laminated Wood Bridge Decks**
Author: Michael A. Ritter, Paula D. Hilbrich Lee
Publisher: USDA Forest Service, FPL
Year Published: 1997 Number of Pages: 8

Library ID: **02-0039 *cont.***

Since their introduction in the late 1980's, more than 400 stress-laminated wood deck bridges have been built in the United States. Although there are guide specifications for the design of these bridges, little information exists on proper construction practices. Most bridges have been built by local governments with widespread geographical distribution. Therefore, little opportunity exists for local jurisdictions and contractors to gain experience in stress-laminated construction. As a result, there is confusion regarding proper construction methodology, and practices that adversely affect bridge performance continue to perpetuate as new structures are built. This paper summarizes recommended construction practices for stress-laminated lumber bridge decks, including bridge materials, assembly, and bar tensioning.

Library ID: 02-0040

Title: **LRFD for Engineered Wood Structures-Connection Behavioral Equations**

Author: Thomas E. McLain, Lawrence A. Soltis, David G. Pollock, Jr., Thomas L. Wilkinson

Publisher: American Society of Civil Engineers, Journal of Structural Engineering

Year Published: 1993 Number of Pages: 15

A new design specification for engineered wood structures has been proposed in load and resistance factor design (LRFD) format. This paper provides an overview of the proposed LRFD connections design criteria. The connections design provisions are, in part, calibrated from allowable stress design provisions. Major changes from historic practice, however, result from a change in behavioral equations to a theoretical base for predicting the lateral strength of connections using bolts, screws, and nails. New provisions for axial withdrawal of driven and turned fasteners, as well as combined axial and lateral loading criteria are also proposed. Safety levels were calibrated to historic practice, but some change in design capacity is expected due to format change, conversion to new behavioral equations, and the selection of a calibration point. The LRFD document contains substantial improvement in code clarity, simplification, and structure over the historic allowable stress specification. A clear mechanism for including design with new wood-based engineering materials is provided.

Library ID: 02-0041

Title: **Shear Strength of Unchecked Glued-Laminated Beams**

Author: Lawrence A. Soltis, Douglas R. Rammer

Publisher: Forest Products Society

Year Published: 1994 Number of Pages: 7

The allowable stress in shear is derived from shear tests of small clear shear blocks, but the shear strength of shear blocks is much greater than the shear strength of larger beams. In this study, glued-laminated beams were tested to determine shear strength. These specifications were tested in the five-point bending test configuration. Shear blocks were cut from the beam after failure and tested for shear strength. From these tests, a relationship between shear strength and beam size was developed that uses American Society for Testing and Materials (ASTM) shear block strength as a basis. The recommended relationship is based on test results for a number of sizes of Douglas-fir and southern pine unchecked glued-laminated beams. This recommendation also includes the stress concentration factor to account for the effects of the re-entrant corner in the ASTM shear block specimen.

Library ID: 02-0043

Title: **Log Stringer Trail Bridge Design Aid**

Author: USDA Forest Service, Region 1 Engineering Staff

Publisher: USDA Forest Service, Region 1

Year Published: 1997 Number of Pages: 1

Pedestrian bridge design aid for log stringer trail bridge, drawing no. 1790.

Library ID: 02-0044

Title: **Open Web Joist Trail Bridge Design Aid**

Author: USDA Forest Service, Region 1 Engineering Staff

Publisher: USDA Forest Service, Region 1

Year Published: 1997 Number of Pages: 1

Pedestrian bridge design aid for open web joist trail bridge, drawing no. 1791.

Library ID: 02-0045

Title: **Glued Laminated-Nail Laminated Slab Trail Bridge Design Aid**

Author: USDA Forest Service, Region 1 Engineering Staff

Publisher: USDA Forest Service, Region 1

Year Published: 1997 Number of Pages: 1

Pedestrian bridge design aid for glued laminated-nail laminated slab trail bridge, drawing no. 1792.

Library ID: 02-0046

Title: **Plans for Crash-Tested Wood Bridge Railings for Concrete Decks**

Author: Michael A. Ritter, Ronald K. Faller, Paula D. Hilbrich Lee, Barry T. Rosson, Sheila Rimal Duwadi

Publisher: USDA Forest Service, FPL

Year Published: 1999 Number of Pages: 17

URL: http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr108/fplgtr108.htm

As part of a continuing cooperative research between the Midwest Roadside Safety Facility (MwRSF); the USDA Forest Service, Forest Products Laboratory (FPL); and the Federal Highway Administration (FHwA), several crashworthy wood bridge railings and approach railing transitions have been adapted for use on concrete bridge decks. These railings meet testing and evaluation criteria outlined in National Cooperative Highway Research Program (NCHRP) Report 350, Recommended Procedures for the Safety Performance Evaluation of Highway Features, and include a glued-laminated timber (glulam) rail, with and without a curb, at Test Level-2 (TL-2), a glulam rail with curb at TL-4, and a glulam curb rail for low-volume roads at TL-1. In adapting the railings from a wood deck to a concrete deck, the critical consideration was railing attachment to the deck. A comparable connection was obtained by an analysis of maximum loads measured by field instrumentation during crash testing or by equating the ultimate capacity of connections used on the wood deck to those required for a concrete deck. For the convenience of the user, full drawing sets are provided in customary U.S. and S.I. units.

Library ID: 02-0047

Title: **Plans for Crash-Tested Bridge Railings for Longitudinal Wood Decks on Low-Volume Roads**

Author: Michael A. Ritter, Ronald K. Faller, Steve Bunnell, Paula D. Hilbrich Lee, Barry T. Rosson

Publisher: USDA Forest Service, FPL

Year Published: 1999 Number of Pages: 11

URL: http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr107/fplgtr107.htm

The plans for crashworthy bridge railing for low-volume roads were developed through a cooperative research program involving the USDA Forest Service, Forest Products Laboratory (FPL); the Midwest Roadside Safety Facility, University of Nebraska-Lincoln (MwRSF); and the Forest Service, National Forest System, Engineering. Three railings were developed and successfully tested in accordance with National Cooperative Highway Research Program (NCHRP) Report 350 Test Level-1 requirements. The fourth system was developed for a lower test level based on criteria developed by the Forest Service for single-lane bridges on very low-volume roads. For the convenience of the user, full drawing sets are provided in customary U.S. and S.I. units.

Library ID: 02-0048

Title: **Design and Construction of the Pochuck Quagmire Bridge - A Suspension Timber Bridge**

Author: Tibor Latincsics

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 130

URL: http://www.fs.fed.us/na/wit/pdf/pochuck/pochuck.html

This publication provides practical, cost-effective design and construction guidelines for a timber pedestrian suspension bridge. It presents basic engineering design criteria and construction tips as well as material, machinery, and peoplepower costs and needs. This information can be used as a general planning tool by anyone wishing to construct a suspension bridge. However, consultation with a licensed professional engineer (P.E.) with expertise in these structures is needed before undertaking such a project.

Library ID: 02-0048 *cont.*

Suspension bridges, like the Pochuck Quagmire Bridge (PQB), provide a solution to long-span crossings. Plans and photography of it and other pedestrian suspension bridges are featured throughout this publication. The materials used to build this 146-foot-long bridge cost $36,000. It was constructed by a unique volunteer-driven, public-private partnership between the NY-NJ Trail Conference, the New Jersey Department of Environmental Protection (NJDEP), and the Appalachian Trail Conference. The Pochuck Quagmire Bridge is located on the Appalachian Trail in Vernon Valley, New Jersey, and is a vital link in the Appalachian Trail.

Library ID: 02-0049

Title: **Standard Plans for Glulam Timber Pedestrian Bridges**

Authors: Patrick S. Powers, Perry D. Schram

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 85

The development of standardized pedestrian timber bridge plans and specifications is a key element in improving design and construction practices. The bridge plans presented were developed as a cooperative effort between the USDA Forest Service, Wood In Transportation Program; the PA Department of Conservation and Natural Resources; and the PA Rural Development Council; and Powers & Schram Inc., Consulting Engineers. This publication contains standardized designs and details for two timber bridge superstructure types, including longitudinal glued-laminated timber (glulam) stringer bridges with transverse timber decks, and longitudinal glulam panel bridges. The set of standards encompasses numerous span length and width combinations, design loads for an AASHTO H-10 vehicle, and pedestrian live loads.

Library ID: 02-0060

Title: **Standard Plans for Timber Bridge Superstructures**

Author: James P. Wacker, Matthew S. Smith

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 53

The bridge plans presented in this publication are part of a series of standardized plans being developed for timber bridges. The plans include standardized designs and details for seven timber bridge superstructure types including five longitudinal deck and two beam systems utilizing both sawn lumber and glued laminated timber (glulam).

Library ID: 02-0061

Title: **Standard Design for a Skidder Bridge**

Author: Merv Eriksson

Publisher: USDA Forest Service — NWITIC

Year Published: 2001 Number of Pages: 6

Section 02 — Design and Bridge Plans *cont.*

Library ID: 02-0062

Title: **Design of Wood Highway Sound Barriers**

Author: Thomas E. Boothby, Courtney B. Burroughs, Craig A. Bernecker, Harvey B. Manbeck, Michael A. Ritter, Stefan Grgurevich, Stephen Cegelka, Paula D. Hillbrich Lee

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 69

As new and existing U.S. residential areas and high volume highways continue to intermingle, traffic noise abatement procedures continue to be important. This study investigated the acoustic effectiveness, public acceptance, and structural requirements of various designs and types of sound barriers. In addition, the acoustic effectiveness of a prototype sound barrier is reported. Results are presented on the acoustic effectiveness from in-situ measurements of one cement bonded composite panel barrier and four precast concrete, two plywood, two glued-laminated, and three post and panel barriers. The research on public acceptance of sound barriers focused on the perception of visual compatibility. Based on results from semantic-differential and individual ratings, wood and concrete barrier designs were perceived to have favored "rural" qualities. Data collected during the research on acoustic effectiveness and public acceptance were used to develop structural requirements and construction details for a prototype wood sound barrier. The prototype wood sound barrier provided insertion losses of 15 dB or greater, exceeding the 10-dB acceptable performance for a highway sound barrier.

Section 03 — Inspection

Library ID: 03-0001

Title: **Nondestructive Testing for Assessing Wood Members in Structures: A Review**

Author: Robert J. Ross, Roy F. Pellerin

Publisher: USDA Forest Service, FPL

Year Published: 1994 Number of Pages: 39

Numerous organizations have conducted research to develop nondestructive testing (NDT) techniques for assessing the condition of wood members in structures. A review of this research was published in 1991. This is an update of the 1991 report. It presents a comprehensive review of published research on the development and use of NDT tools for in-place assessment of wood members. It examines the fundamental hypothesis behind NDT of wood, reviews several widely used NDT techniques, and summarizes results of projects that focused on laboratory verification of the fundamental hypothesis. Results obtained from projects that used NDT techniques for in-place evaluation of wood members are presented. In addition, recommendations are given for future in-place assessment NDT research.

Library ID: 03-0002

Title: **Determining In-Situ Timber Pile Length Using Stress Waves**

Author: Engineering Data Management, Inc.

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1992 Number of Pages: 18

Recognizing the need to uniformly evaluate bridge scour, the Federal Highway Administration (FHwA) published a Technical Advisory on the scour of bridges (FHwA, 1988). This Technical Advisory is used to address the effects of bridge scour in the design process and inspection of existing structures within the National Bridge Inspection Standards Program.

Library ID: 03-0003

Title: **Wood Bridges - Decay Inspection and Control**

Author: Wallace E. Eslyn, Joe W. Clark

Publisher: USDA Forest Service, FPL

Year Published: 1979 Number of Pages: 35

Section 03 — Inspection *cont.*

Library ID: 03-0003 *cont.*

Basic information relating to the cause of decay, to conditions conducive to its initiation and spread, and to means of preventing its occurrence is provided. Procedures for inspecting wood bridges for presence of decay are covered, including steps in preparing for inspection, visual signs of decay, and methods of detecting internal and external decay. Means of controlling existing decay or of preventing new infections are detailed.

Library ID: 03-0005

Title: **Evaluation of Timber Bridges Using Stress Wave Technology**

Author: R. Pellerin, R. Ross, R. Falk, N. Volny

Publisher: Pacific Timber Engineering Conference

Year Published: 1994 Number of Pages: 8

The focus of this research was to develop stress wave nondestructive evaluation (NDE) techniques for determination of the in-plane properties and strength of timber bridge components.

Library ID: 03-0007

Title: **Inspection of Timber Bridges Using Stress Wave Timing Nondestructive Evaluation Tools**

Author: Robert J. Ross, Roy F. Pellerin, Norbert Volny, William W. Salsig, Robert H. Falk

Publisher: USDA Forest Service, FPL

Year Published: 1999 Number of Pages: 15

URL: http://www.fpl.fs.fed.us/documnts/FPLGTR/fplgtr114.pdf

This guide was prepared to assist inspectors in the use of stress wave timing instruments and the various methods of locating and defining areas of decay in timber bridge members. The first two sections provide (a) background information regarding conventional methods to locate and measure decay in timber bridges and (b) the principles of stress wave nondestructive testing and its measurement techniques. The last section is a detailed description of how to apply the field use of stress wave nondestructive testing methods. A sample field data acquisition form and additional reference material are included in the Appendix. This guide includes all the information needed to begin to utilize and interpret results from stress wave timing nondestructive evaluation methods.

Section 04 — Maintenance and Rehabilitation

Library ID: 04-0002

Title: **Performance and Rehabilitation of Timber Bridges**

Author: William J. McCutcheon, Richard M. Gutkowski, Russell C. Moody

Publisher: Transportation Research Board

Year Published: 1986 Number of Pages: 3

Eighteen timber bridges were inspected to assess their long-term performance. In general, they were in excellent structural condition with glued-laminated decks performing better than nail-laminated decks. Extensive moisture content readings indicated that wet-use stresses should be used when designing bridge decks, regardless of deck type or treatment. Dry-use stresses are appropriate for the stringers. A comprehensive program, including new technologies and demonstration projects, must be developed to address the repair and rehabilitation of older nailed-laminated decks.

Library ID: 04-0003

Title: **Techniques to Bring New Life to Timber Bridges**

Author: Frank W. Muchmore

Publisher: USDA Forest Service, NFS

Year Published: 1985 Number of Pages: 17

Section 04 — Maintenance and Rehabilitation *cont.*

Library ID: 04-0003 *cont.*

This paper describes the extensive Forest Service transportation system, one of the world's largest, and its role in the economy of the United States. About 6,500 of the roughly 13,000 bridges on this 330,000-mile (531,000-km) system have wood as a major structural component. Reasons why wood is a viable and competitive structural material are discussed. Inspection procedures to detect decay and conditions conducive to decay are discussed, as well as preservative treatments, which are used to minimize decay. A method to determine strength loss due to decay is presented. Timber bridge maintenance is discussed from the standpoint of preventive, early remedial, and major maintenance. Examples of bridge rehabilitation (major maintenance) of deteriorated and substandard timber bridges are shown and discussed.

Library ID: 04-0005

Title: **Maintenance Practices for Wood Bridges**

Author: Michael A. Ritter, Thomas G. Williamson

Publisher: American Society of Civil Engineers

Year Published: 1995 Number of Pages: 6

Proper maintenance is necessary for the continued safe performance of bridges. In times of fiscal constraint, maintenance becomes increasingly important as funding for bridge replacement decreases and existing bridges must continue to safely support traffic loads. Many bridges in our transportation system are made of wood and require specific maintenance unique to wood structures. This paper summarizes several inexpensive maintenance practices for wood bridges, including moisture control, surface treatments, and fumigants.

Section 05 — Preservative Treatment

Library ID: 05-0001

Title: **Selection and Use of Preservative Treated Wood in Forest Service Recreational Structures**

Author: Stan T. LeBow, William J. Makel

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 12

This article is intended to give the reader an overview of preservative systems, aid in understanding the level of risk and status of the science, and provide some guidelines for using the products.

Library ID: 05-0002

Title: **AWPI Consumers Guide to the Proper Use of Treated Wood**

Author: American Wood Preservers Institute (APWI)

Publisher: APWI

Year Published: unkn Number of Pages: 8

Wood is an attractive, versatile, easily handled building material. Pressure treatment protects it from decay, fungi, and insect infestation by removing one of the elements that must be present for these decay organisms to thrive, food. The chemicals used to permeate wood under pressure, pentachlorophenol, creosote, and inorganic arsenicals, are registered by the Environmental Protection Agency and certain precautions should be taken when handling the wood and installing it in projects. Exposure to the chemicals may present certain hazards. The following pages are worded by the EPA and the precautions outlined should always be observed when handling treated wood and determining how it should be used.

Library ID: 05-0005

Title: **Preservative Treatment of Hardwoods: A Review**

Author: Warren S. Thompson, Peter Koch

Publisher: USDA Forest Service, FPL

Year Published: 1981 Number of Pages: 47

This report reviews information on the treatment of some 56 American hardwood species with more than a dozen preservatives by variations of five pressure and four non-pressure treatment methods, together with data from softwood tests of materials and methods for which hardwood test results are not available. Also reviewed are data on impregnation of hardwoods for stabilization and to improve resistance to fire.

Library ID: 05-0007

Title: **Treated Wood Products, Their Effect on the Environment**

Author: D. A. Webb, L. R. Gjovik

Publisher: USDA Forest Service, FPL

Year Published: 1988 Number of Pages: 6

Library ID: 05-0010

Title: **Corrosion Protection of Steel Hardware Used in Modern Timber Bridges**

Author: J. F. Davalos, S. H. Petro

Publisher: USDOT FHwA

Year Published: 1993 Number of Pages: 50

Corrosion of steel components and connectors used in timber bridges can cause structural damage and failure. The steel hardware is usually exposed to corrosive environments, and therefore, inadequate corrosion protection and favorable conditions for galvanic reactions can promote the onset of corrosion and lead to unexpected failures. In particular, the steel stressing system and special connectors used in modern timber bridges, such as stress-laminated and glued-laminated systems, must be adequately protected against corrosion and inspected frequently. The objectives of this booklet are: (1) to familiarize the bridge engineer with the steel components and fasteners used in timber bridges that may corrode and with the types of corrosion that may occur on those components, and (2) to recommend corrosion prevention measures (galvanizing and epoxy coating) applied to the steel components and to provide inspection guidelines for quality control and inservice maintenance of these components. A simple explanation of the corrosion mechanism and its causes is presented, followed by a detailed discussion of the quality control and inspection of galvanized and epoxy-coated steel articles. The inspector is alerted to potential corrosion treatment problems (e.g., Hydrogen embattlement) that must be avoided. Checklists are provided for quality control of treated steel articles and inservice maintenance of timber bridge steel components. This publication is part of a collection of three booklets of the study "Education and Technology Transfer," under the Timber Bridge Research Program. The other two booklets are: FHWA-RD-91-120 Design, Construction, and Quality Control Guidelines for Stress-Laminated Timber Bridge Decks, FHWA-RD-93-024 Timber Structures for Bridge Applications

Library ID: 05-0011

Title: **Wood Preservation In West Virginia - Appalachian Hardwood Center: Fact Sheet 9**

Author: Appalachian Hardwood Center (AHC), Division of Forestry, West Virginia University

Publisher: AHC

Year Published: 1992 Number of Pages: 8

Information given on serious investigations of preserving hardwood species.

Library ID: 05-0013

Title: **Leaching of Wood Preservative Components and Their Mobility in the Environment - Summary of Pertinent Literature**

Author: Stan LeBow

Publisher: USDA Forest Service, FPL

Year Published: 1996 Number of Pages: 36

Preservative-treated wood is an economical, durable, and aesthetically pleasing building material; therefore, it is a natural choice for construction projects in our National Forests, National Parks, and other public lands. However, we need to ensure that the chemicals used in treated wood do not pose a threat to people or the environment. The purpose of this report is to provide a summary of the pertinent literature on leaching of wood preservative components and their mobility in the environment. The waterborne wood preservatives chromated copper arsenate (CCA), ammoniacal copper zinc arsenate (ACZA), ammoniacal copper quat (ACQ), copper dimethyldithio-carbarnate (CDDC), and ammoniacal copper citrate (CC) resist leaching during service because of complex chemical reactions that take place within the treated wood. The effectiveness of these reactions in preventing leaching is dependent on treating factors, such as preservatives formation, preservative retention, and processing techniques, as well as post-treatment conditioning factors, such as temperature, humidity, and air flow. Copper naphthenate, an oilborne wood preservative, resists leaching because it is relatively insoluble in water. Little information is available on the in-service leaching rates of any of these wood preservatives, although CCA has been studied more extensively than the other preservatives.

Library ID: 05-0014

Title: **Preservative Treatment of Red Maple**

Author: William B. Smith, Nazri Abdullah, Douglas Herdman, Rodney C. DeGroot

Publisher: Forest Products Society

Year Published: 1996 Number of Pages: 7

The development of additional preservative treatments for underutilized eastern hardwoods, such as red maple, is critical to the development of new market opportunities that require long-term utilization of hardwoods in exterior structures. This project investigated the treatability of red maple sapwood and heartwood with water, toluene, CCA (chromated copper arsenate), ACQ (ammonium copper didecyldimethylammonium chloride), creosote, and toulene- and waterborne copper naphthenate. The efficacy of CCA, and of water- and oilborne copper naphthenate against a brown-rot fungus *(Postia placenta)*, a white-rot fungus *(Trametes versicolor)*, and a soft-rot fungus *(Chaetomium globosum)* was also determined using sapwood blocks in agar block decay tests. Substantial differences were found between heartwood and sapwood treatability. Full-cell impregnation resulted in sapwood samples being thoroughly penetrated and consistently treated to retentions of 30 to 40 pcf (lb. solution/ft.^{3} wood). Preservatives penetrated heartwood only about 3 mm transversely and 15 mm longitudinally. Retentions ranged from 5 to 15 pcf. On an equivalent copper loading basis, the oilborne copper naphthenate was more effective than the waterborne formulation against white- and soft-rot fungi. CCA protected maple sapwood against brown- and white-rot fungi at low retentions, 0.1 percent copper weight/weight. Similar to past work, however, higher loadings were needed for soft-rot protection.

Library ID: 05-0016

Title: **Working for Rural America; Wood Double-Diffusion Treatment Plant, Tyonek Native Corporation, Kenai Borough, Alaska**

Author: Kasey Russell, Ken Kilborn

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1997 Number of Pages: 5

The Tyonek Double-Diffusion Treatment plant is a wood products facility that employs six people. This plant has enabled a rural community to take research knowledge collected over the last 50 years and combine it with local renewable timber resources and labor to improve their community's transportation infrastructure.

Library ID: 05-0021

Title: **Distribution of Borates Around Point Source Injections in Wood Members Exposed Outside**

Authors: Rodney C. DeGroot, Colin C. Felton, Douglas M. Crawford

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 5
URL: http://www.fpl.fs.fed.us/documnts/fplrn/fplrn275.pdf

In bridge timbers, wood decay is usually found where water has accessed the end-grain surfaces. In preservative-treated members, end-grain surfaces are most likely to be those resulting from on-site framing cuts or borings. Because these at-risk surfaces are easy to see, it seems feasible to establish a program where diffusible preservatives are repetitively inserted into those critical areas spatially distributed in a grid and on a schedule that will ensure protection, thereby extending the life of the entire structure. The objective of this study was to determine the vertical and lateral distribution and the post-treatment behavior of injected and inserted borate preservatives in wood exposed to natural wetting in field exposure.

Library ID: 05-0023

Title: **Assessment of the Environmental Effects Associated with Wood Bridges Preserved with Creosote, Pentachlorophenol, or Chromated Copper Arsenate**

Authors: Kenneth M. Brooks

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 100
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp587.pdf

Timber bridges provide an economical alternative to concrete and steel structures, particularly in rural areas with light to moderated vehicle traffic. This report describes the concentration of wood preservatives lost to adjacent environments and the biological response to these preservatives as environmental contaminants. Six bridges from various states were examined for risk assessment: two creosote-treated bridges, two pentachlorophenol-treated bridges, and two CCA-treated bridges. The observed levels of contaminant were compared with available regulatory standards or benchmarks and with the quantitative description of the aquatic invertebrate community sampled from vegetation and sediments.

Library ID: 05-0024

Title: **Role of Construction Debris in Release of Copper, Chromium, and Arsenic From Treated Wood Structures**

Authors: Stan T. Lebow, Steven A. Halverson, Jeffrey J. Morrell, John Simonsen

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 6
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp584.pdf

Recent research on the release of wood preservatives from treated wood used in sensitive environments has not considered the potential contribution from construction residues. This study sought to develop leaching rate data for small construction debris and compare those to the release rate from treated wood itself. Western hemlock boards were pressure treated with chromated copper arsenate - Type C (CCA-C), and then common construction tools were used to generate sawdust or shavings from those boards. These wood particles were then leached in deionized water, and the leaching rate was compared with that of solid wood samples cut from the same specimen. Released rate data from this study were also compared with those from end-matched samples that were leached in artificial rain in an earlier study. The release rates of copper, chromium, and arsenic from CCA-C treated chainsaw sawdust, circular saw sawdust, and spade bit shavings were many times higher than from solid wood when samples were immersed in water. There was little difference in the release rates among the three types of shavings and sawdust, despite differences in their particle sizes. The rates of release from decking exposed to rainfall were many times lower than that of construction debris or solid wood continually immersed in water. These results show the importance of minimizing the amount of construction debris that is allowed to enter the aquatic environment. However, example calculations also demonstrate that if reasonable efforts are made to minimize release of construction debris, the contribution of these particles to the overall release of preservative from the structure will be minimal.

Section 05 — Preservative Treatment *cont.*

Library ID: 05-0025

Title: **Guide for Minimizing the Effects of Preservative-Treated Wood on Sensitive Environments**

Author: Stan T. Lebow, Michael Tippie

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 18

Preservative-treated wood is often used for construction of highway and pedestrian bridges, wetland boardwalks, and other structures in or over water or sensitive environments. In these applications, it is important that release of preservative from the wood into the environment is minimized. This publication addresses this concern by describing the various types of pressure-treated wood, reviewing recent research on the environmental impacts of pressure-treated wood, and discussing methods of minimizing potential environmental impacts. Recent research indicates that wood treated with these preservatives does release small amounts of chemical into the environment immediately adjacent to the treated structure, although no adverse biological impacts were observed. Environmental releases from treated wood can be minimized with appropriate treatment practices. These practices include fabricating members before treatment and specifying that the wood be treated using methods that ensure chemical fixation and prevent the formation of surface residues or bleeding. Guidance to specifying such treating practices are offered in this report and in sources such as the Best Management Practices developed by the Western Wood Preservers' Institute. Also, responsible construction practices such as storage of treated wood under cover and containment and collection of construction residue can further reduce the possibility of negative environmental impacts. As with any other construction material, careful specification and responsible use of treated wood will optimize its performance.

Library ID: 05-0026

Title: **Effects of Wood Preservatives on Stress-Laminated Southern Pine Bridge Test Decks**

Author: James A. Kainz, Nur Yazdani, Joy Kadnar

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 12

For wood to work successfully in external environments, it must be treated with chemical preservatives. This study determined the effect of various oil- and water-based preservatives on the performance of stress-laminated Southern Pine bridge decks. This 2-1/2 year study was limited to one species for the wood laminations and one type of stress-laminated system. Nine half-width, full-length stress-laminated test decks were constructed of Southern Pine lumber. Each test deck was treated with one of seven preservatives and outfitted with one of three bar anchorage types. Moisture content levels did not change significantly throughout the monitoring period, which implies that the wood had achieved moisture equilibrium prior to testing. According to this study, when Southern Pine stress-laminated bridge decks are properly designed, (1) the anchorage system has a negligible effect on bar force retention and (2) water-based preservatives may be successfully used to treat these bridge decks. We recommend that the design guidelines currently available for stress-laminated decks treated with oil-based preservatives be extended to decks treated with water-based preservatives and constructed with any bar anchorage system. This recommendation is based on the similarity of the behavior of water- and oil-based preservatives in the stress-laminated test decks treated in this study.

Section 06 — Monitoring and Performance

Library ID: 06-0001

Title: **Field Performance of Timber Bridges 1. Teal River Stress-Laminated Deck Bridge**

Author: James P. Wacker, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1992 Number of Pages: 19

The Teal River bridge was constructed in late 1989 in Sawyer County, Wisconsin, as a part of the demonstration timber bridge program of the USDA Forest Service. The bridge is a stress-laminated deck structure with a 32.5-ft length and 23.7-ft width. The design is unique in that it is the first known stress-laminated timber bridge in the United States to be constructed of full-span glued-laminated timber beams, rather than the traditionally used sawn lumber laminations. The performance of the bridge was continuously monitored for 2 years, beginning at the time of installation. The performance monitoring involved gathering data relative to the moisture content of the wood deck, the force level of stressing bars, the deck dead load deflection, and the behavior of the bridge under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on 2 years of field evaluations, the bridge is performing well with no structural or service ability deficiencies.

Library ID: 06-0002

Title: **Field Performance of Timber Bridges 2. Cooper Creek Stress-Laminated Deck Bridge**

Author: Michael A. Ritter, James P. Wacker, Everett D. Tice

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 17

The Cooper Creek bridge was constructed in February 1992, in Centerville, Iowa. The bridge is a two-span, continuous stress-laminated deck structure 42-ft long and approximately 26.5-ft wide. The bridge is unique in that it is one of the first known stress-laminated timber bridge applications to use eastern cottonwood. The performance of the bridge was monitored continuously for 28 months beginning at the time of installation. Performance monitoring involved gathering and evaluating data relative to the moisture content of the wood deck, force level of the stressing bars, vertical creep, and behavior of the bridge under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well with no structural or serviceability deficiencies.

Library ID: 06-0003

Title: **Field Performance of Timber Bridges 3. Birchlog Run and Tumbling Rock Run Stress-Laminated Deck Bridge**

Author: James P. Wacker, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 11

URL: http://www.fpl.fs.fed.us/documnts/FPLRP/fplRP538.pdf

The Birchlog Run and Tumbling Rock Run bridges were constructed in the summer of 1990 on the Monongahela National Forest in West Virginia. The bridges are simple span, single-lane, stress-laminated deck superstructures, and each bridge is approximately 30-ft long and 13-ft wide. The bridges are located approximately 1/2 mile apart and are nearly identical in design. However, the Birchlog Run bridge is constructed of Southern Pine (softwood) lumber, and the Tumbling Rock Run Bridge is constructed of Northern Red Oak (hardwood) lumber. The close proximity of the bridges provided an opportunity to compare the performance of stress-laminated decks constructed of softwood and hardwood species under similar environmental conditions. Performance of the bridges was monitored for 3 years, beginning at the time of installation. This monitoring involved gathering and analyzing data relative to the wood moisture content, force level of the stressing bars, vertical bridge creep, and behavior of the bridges under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the bridges. Based on 3 years of field monitoring, the bridges are performing well with no structural or serviceability deficiencies.

Library ID: 06-0004

Title: **Field Performance of Timber Bridges 4. Graves Crossing Stress-Laminated Deck Bridge**

Author: James P. Wacker, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 17

URL: http://www.fpl.fs.fed.us/documnts/FPLRP/fplRP539.pdf

The Graves Crossing bridge was constructed October 1991 in Antrim County, Michigan, as part of the demonstration timber bridge program sponsored by the USDA Forest Service. The bridge is a two-span continuous, stress-laminated deck superstructure and it is 36-ft long and 26-ft wide. The bridge is one of the first stress-laminated deck bridges to be built of sawn lumber treated with chromated copper arsenate (CCA) preservative. The performance of the bridge was continuously monitored for 2 years, beginning at the time of installation. This performance monitoring involved gathering and evaluating data relative to the stiffness of the lumber laminations, the moisture content of the wood deck, the force level in the stressing bars, and the behavior of the bridge under static truck loading. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on 2 years of field observations, the bridge is performing well with no structural or serviceability deficiencies.

Library ID: 06-0005

Title: **Field Performance of Timber Bridges 5. Little Salmon Creek Stress-Laminated Deck Bridge**

Author: Michael A. Ritter, James A. Kainz, Gregory J. Porter

Publisher: USDA Forest Service, FPL

Year Published: 1996 Number of Pages: 15

URL: http://www.fpl.fs.fed.us/DOCUMNTS/Fplrp/fplrp547.pdf

The Little Salmon Creek Bridge was constructed in November 1988 on the Allegheny National Forest in Pennsylvania. The bridge is a simple span, single-lane, stress-laminated deck superstructure that is approximately 26-ft long and 16-ft wide. The bridge is unique in that it is the first known stress-laminated timber bridge to be constructed of hardwood lumber. The performance of the bridge was monitored continuously for approximately 4 years, beginning at the time of installation. Performance monitoring involved gathering and evaluating data relative to the moisture content of the wood deck, the force level of stressing bars, the deck vertical creep, and the behavior of the bridge under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well with non-structural deficiencies, although the bridge has developed a slight sag as a result of vertical creep.

Library ID: 06-0006

Title: **Field Performance of Timber Bridges 8. Lynches Woods Park Stress-Laminated Deck Bridge**

Author: James P. Wacker, Michael A. Ritter, Don Conger

Publisher: USDA Forest Service, FPL

Year Published: 1996 Number of Pages: 17

The Lynches Woods Park bridge was constructed during the summer of 1990 in Newberry, South Carolina. It is a single-span, single-lane, stress-laminated deck superstructure that measures approximately 30-ft long, 16-ft wide, and 14-in. deep. The bridge is unique in that it is one of the first known stress-laminated deck bridges to be constructed of Southern Pine lumber treated with chromated copper arsenate. The performance of the bridge was continuously monitored for approximately 3 years, beginning 10 months after installation. Performance monitoring involved gathering and analyzing data relative to the wood moisture content, force level in the stressing bars, and behavior under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall structure condition. Based on the field evaluations, the bridge is performing well with no structural or serviceability deficiencies.

Library ID: 06-0007

Title: **Field Monitoring of A Stressed Timber Bridge Over Elk Two-Mile Creek**

Author: Barry Dickson, Dr. Hota V. S. GangaRao

Publisher: 6th Annual International Bridge Conference

Year Published: 1989 Number of Pages: 7

This publication monitored a stressed timber bridge over Elk Two-Mile Creek. This was done through various tests and monitoring programs. The results of these tests are discussed.

Library ID: 06-0009

Title: **Comparative Performance of Timber Bridges**

Author: Richard M. Gutkowski, William J. McCutcheon

Publisher: Journal of Structural Engineering

Year Published: 1987 Number of Pages: 19

Eighteen timber bridges built in the late 1960s and early 1970s are inspected to determine the performance of their various components. In general, the bridges are in excellent structural condition. Glulam decks provide effective "roofs" over stringers as shown by relatively low moisture content readings in the stringers. The findings support the use of dry design stresses for stringers but not for decks.

Library ID: 06-0011

Title: **The Mormon Creek Bridge - Performance After Three Years**

Author: William J. McCutcheon

Publisher: USDA Forest Service, NFS

Year Published: 1992 Number of Pages: 8

The Mormon Creek Bridge is an experimental parallel-chord, stress-laminated deck design. It is the first of its kind and has been in service for more than 3 years. The structural performance and experimental features of the bridge have been monitored continuously during this time. Overall, the performance has been excellent. The only problem has been with crushing of the original softwood stress blocks; this was corrected by replacing the blocks with hardwood blocks. The parallel-chord, stress-laminated bridge appears to be a viable alternative to more conventional designs.

Library ID: 06-0013

Title: **Stress-Laminated Wood Bridge Decks - Experimental and Analytical Evaluations**

Author: Michael G. Oliva, Al G. Dimakis, Michael A. Ritter, Roger L. Tuomi

Publisher: USDA Forest Service, FPL

Year Published: 1990 Number of Pages: 19

Construction of stress-laminated timber decks by transverse prestressing of wood laminate is a relatively new concept that originated in Ontario, Canada. This report presents results of resent research completed on solid wood stress-laminated decks. The primary objective was to quantify the behavior of the bridge decks when loaded with simulated truck loading. Identification of an accurate analytical technique for predicting deck response and development of a new simplified prestressing anchorage and development of a new simplified prestressing anchorage system were also achieved. Our objectives were accomplished through an experimental laboratory test program on full-size bridges followed by computer-aided analytical correlation studies. A summary of the project and experimental and analytical results are presented with conclusions and recommendations for tasks that should be completed before stress-laminated decks are used in bridge construction.

Library ID: 06-0014

Title: **Field Performance of U.S. Stress-Laminated Wood Bridges**

Author: Michael A. Ritter, Michael G. Oliva

Publisher: Proceedings of the 1990 International Timber Bridge Engineering Conference

Year Published: 1990 Number of Pages: 6

The concept of stress-laminated bridges is relatively new in the United States. Although bridges of this type have been successfully built since 1976 in Ontario, Canada, few of these bridges were built in the United States prior to 1988, and numerous bridges have been built in the United States since that time. To evaluate the performance of stress-laminated bridge systems built in the United States, the USDA Forest Service, Forest Products Laboratory, has implemented a nationwide bridge monitoring program. This paper presents preliminary monitoring results from six stress-laminated bridges that have been continually monitored for 1 year or more. Included are discussions related to moisture content, stressing rod force, anchorage systems performance, vertical creep, load test behavior, wearing surface performance, and stressing system corrosion.

Library ID: 06-0015

Title: **Methods for Assessing the Field Performance of Stress-Laminated Timber Bridges**

Author: Michael A. Ritter, Earl A. Geske, William J. McCutcheon, Russell C. Moody, James P. Wacker, Lola E. Mason

Publisher: 1991 International Timber Engineering Conference, London, UK

Year Published: 1991 Number of Pages: 8

The Forest Products Laboratory has been involved in the monitoring of stress-laminated timber bridges since 1988. To effectively and economically implement this cooperative monitoring program, the FPL developed unified test procedures that employ simple, reliable methods to assess bridge performance. Included are methods to evaluate stressing bar force, lamination moisture content, vertical creep, and bridge behavior under load. The methods used have been refined over several years and have proven to reliably reflect bridge performance.

Library ID: 06-0016

Title: **Load Distribution in Glued-Laminated Longitudinal Timber Deck Highway Bridges**

Author: W. W. Sanders, Jr., F. W. Klaiber, T. J. Wipf

Publisher: American Institute of Timber Construction

Year Published: 1985 Number of Pages: 47

In recent years changes in the load distribution criteria for highway bridges have been limited primarily to steel and concrete bridges. Only a few changes have occurred with regard to timber bridges. Several years ago the AASHTO Bridge Committee did approve the inclusion of criteria for glued laminated stringer bridges. However, the glued laminated longitudinal timber deck bridge developed in recent years has been subject to code specifications that do not reflect the favorable load distribution characteristics of the bridge. Enough test information now exists to verify the distribution behavior. The purpose of this study was to develop criteria that more accurately represent the bridge behavior. The study was conducted in three phases: 1. literature study of both analytical and experimental investigations of load distribution in timber deck bridges; 2. selection of an analytical procedure to study the distribution characteristics of a broad range of glued laminated longitudinal timber deck bridges and verification of this procedure by comparison with actual field test behavior and that of a full-sized laboratory test bridge; and 3. development of proposed criteria for inclusion in the appropriate sections of the AASHTO Bridge Specifications so that they more adequately reflect the load distribution of the glued laminated longitudinal deck bridge. A specific proposal is presented in this report. Supporting information related to the background and development of the proposed criteria are presented.

Library ID: 06-0021

Title: **Field Performance of Stress-Laminated Timber Bridges on Low-Volume Roads**

Author: Michael A. Ritter, James P. Wacker, Sheila Rimal Duwadi

Publisher: National Academy Press

Year Published: 1995 Number of Pages: 10

URL: http://www.fpl.fs.fed.us/documnts/pdf1995/ritte95a.pdf

This paper presents a summary of monitoring results and observations obtained through the program for stress-laminated bridges that have been continuously monitored for 2 years or more. Included are discussions related to bridge construction, moisture content, stressing-bar force, vertical creep, load test behavior, and condition evaluation.

Library ID: 06-0022

Title: **New Technology, Local Labor, Local Material: Timber Bridge Demonstration Project; The North Road Bridge**

Author: Eileen D. Young

Publisher: Cooperative Extension, University of Rhode Island

Year Published: 1995 Number of Pages: 12

This publication discusses a Timber Bridge demonstration project, the North Road Bridge. It includes planning, construction, and monitoring success.

Library ID: 06-0023

Title: **Performance of Steel, Concrete, Prestressed Concrete, and Timber Bridges**

Author: Kim Stanfill-McMillan, Cherilyn A. Hatfield

Publisher: The Canadian Society for Civil Engineering

Year Published: 1994 Number of Pages: 14

The National Bridge Inventory (NBI) in the United States is a comprehensive document that maintains inventory records on all bridges 20 ft (>6 m) or greater in length. Although its records are primarily used by individual states and the Federal government for assessing bridge condition and assigning funding to future projects, the NBI has much useful data that can be used for other purposes, such as developing historical trends in bridge construction, adequacy, and longevity. Recently the USDA Forest Service, Forest Products Laboratory, in cooperation with the USDA Forest Timber Bridge Information Resource Center, completed an analysis of the 1992 NIB to determine historical characteristics of concrete, steel, prestressed concrete, and timber bridges. Comparisons of bridge performance based on historical data were investigated and are presented in this paper. Analysis on material usage, structural and functional adequacy and longevity are included. The construction and performance trends revealed by the data will be useful to bridge designers and managers.

Library ID: 06-0024

Title: **Behavior of Stress-Laminated Parallel-Chord Timber Bridge Decks: Experimental and Analytical Studies**

Author: Al G. Dimakis, Michael G. Oliva, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1992 Number of Pages: 19

The use of stress lamination for constructing timber bridges may provide a solution to urgent need for rehabilitating and replacing U. S. highway bridges. This report describes the development, construction, testing, and analysis of a new type of stress-laminated timber bridge: the parallel-chord bridge. A full-scale laboratory test was conducted on a stress-laminated parallel-chord bridge made with Vierendeel trusses. A similar set of shorter trusses was built for a prototype bridge on the Hiawatha National Forest in Michigan. Test results showed that both of these bridges have greater stiffness and can span longer distances than stress-laminated solid-sawn timber bridges. The stress-laminated parallel-chord bridge system effectively transfers applied loads to a wide portion of the deck trusses. Anchorage configurations have little effect on load resisting behavior as long as the anchorage transfer prestressing force into both chords and webs. Good correlation was found between analytical and experimental results. The stress-laminated parallel-chord bridge is easy to build, but the cost of the superstructure may be limiting.

Library ID: 06-0025

Title: **Dynamic Response of Stress-Laminated Deck Bridges**

Author: M. A. Ritter, D. L. Wood, T. J. Wipf, Chintaka Wijesooriya, S. R. Duwadi

Publisher: National Academy Press

Year Published: 1995 Number of Pages: 14

The objective of the research presented here was to determine the dynamic performance characteristics of three stress-laminated timber bridges. The results for these bridges will be combined with results from additional tests still to be performed and complementary analytical research to prepare design criteria to be submitted to AASHTO for inclusion in the Standard specification for Highway Bridges (6).

Library ID: 06-0026

Title: **Design and Field Performance of a Metal-Plate-Connected Wood Truss Bridge**

Author: Michael H. Triche, Michael A. Ritter, Stuart L. Lewis, Ronald W. Wolfe

Publisher: American Society of Civil Engineers

Year Published: 1994 Number of Pages: 6

This paper describes an on-going study on the design and performance attributes of an experimental wood-truss bridge. This is believed to be the first roadway bridge application of metal-plate-connected wood trusses. Constructed in the Fall of 1992 on a rural Alabama road, the bridge comprises two spans: Span 1 is a bolt-laminated transverse deck supported by multi-truss girders and Span 2 is a stress-laminated truss system. A comprehensive monitoring program, initiated shortly after construction, is providing information on seasonal variations in lumber moisture content, stressing bar forces and overall bridge condition. This includes periodic static load testing. After one year, the monitoring program shows the bridge to be performing as expected.

Library ID: 06-0027

Title: **Factors Influencing Timber Bridge Performance**

Author: Kim Stanfill-McMillan, James A. Kainz

Publisher: American Society of Civil Engineers

Year Published: 1995 Number of Pages: 4

This paper examines National Bridge Inventory data to determine timber bridge performance as affected by maintenance responsibility and design load. Results indicate that design load has the greatest effect on bridge performance. Bridges have higher performance ratings in areas where maintenance is the combined responsibility of state and county or town agencies.

Library ID: 06-0028

Title: **Field Performance of Timber Bridges 6. Hoffman Run Stress-Laminated Deck Bridge**

Author: Michael A. Ritter, Paula D. Hilbrich Lee, Gregory J. Porter

Publisher: USDA Forest Service, FPL

Year Published: 1996 Number of Pages: 16
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp549.pdf

The Hoffman Run bridge, located just outside Dahoga, Pennsylvania, was constructed in October 1990. The bridge is a single-span, single-lane, stress-laminated deck superstructure that is approximately 26-ft long and 16-ft wide. It is the second stress-laminated timber bridge to be constructed of hardwood lumber in Pennsylvania. The performance of the bridge was monitored continually for approximately 32 months, beginning shortly after installation. Performance monitoring involved gathering and evaluating data relative to the moisture content of the wood deck, the force level of steel stressing bars, the deck vertical creep, and the behavior of the bridge under static-load conditions. Furthermore, comprehensive visual inspections were executed to assess the overall condition of the structure. Based on field evaluations, the bridge is performing properly with no structural deficiencies, although with respect to serviceability, the bridge has developed a slight sag at midspan.

Library ID: 06-0029

Title: **Field Performance of Timber Bridges 10. Sanborn Brook Stress-Laminated Deck Bridge**

Author: Paula D. Hillbrich-Lee, Michael A. Ritter, James P. Wacker

Publisher: USDA Forest Service, FPL

Year Published: 1996 Number of Pages: 19
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp555.pdf

The Sanborn Brook bridge was constructed in August 1991, 10 miles northeast of Concord, New Hampshire, as part of the demonstration timber bridge program of the USDA Forest Service. The bridge is a simple-span, double-lane, stress-laminated deck superstructure constructed from Southern Pine lumber and is approximately 25-ft long and 28-ft wide with a skew of 14 degrees. The performance of the bridge was monitored continuously for approximately 2 years, beginning shortly after installation. Performance monitoring involved collecting and evaluating data pertaining to the moisture content of the wood deck, the force level of the stressing bars, the deck vertical creep, and the behavior of the bridge under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well, with no structural or serviceability deficiencies.

Library ID: 06-0030

Title: **Field Performance of Timber Bridges 9. Big Erick's Stress-Laminated Deck Bridge**

Author: James A. Kainz, James P. Wacker, Martin Nelson

Publisher: USDA Forest Service, FPL

Year Published: 1996 Number of Pages: 24
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp552.pdf

The Big Erick's bridge was constructed during September 1992 in Baraga County, Michigan. The bridge is 72-ft long, 16-ft wide, and consists of three simple spans: two stress-laminated deck approach spans and a stress-laminated box center span. The bridge is unique in that it is one of the first known stress-laminated timber bridge applications to use Eastern Hemlock sawn lumber and a combination of stress-laminated decks and a stress-laminated box in a single bridge. Performance of the bridge was monitored for 35 months, beginning at the time of installation. Monitoring involved gathering and evaluating data relative to the moisture content of the wood components, the force level of stressing bars, and the behavior of the bridge under static-load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well, with only minor serviceability deficiencies.

Library ID: 06-0031

Title: **Field Performance of Timber Bridges 11. Spearfish Creek Stress-Laminated Box-Beam Bridge**

Author: James P. Wacker, Michael A. Ritter, Kim Stanfill-McMillan, Nikki T. Brown, Jonathon R. Becker

Publisher: USDA Forest Service, FPL

Year Published: 1997 Number of Pages: 17
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp556.pdf

Library ID: **06-0031 *cont.***

The Spearfish Creek bridge was constructed in 1992 in Spearfish, South Dakota. It is a single-span, stress-laminated, box-beam superstructure. Performance of the bridge is being monitored for 5 years, beginning at installation. This report summarizes results for the first 3-1/2 years of monitoring and includes information on the design, construction, and field evaluations of the wood moisture content, force level in the stressing bars, behavior under static loading, and overall structure condition. Based on field evaluations, the bridge is performing satisfactorily with no structural or serviceability deficiencies. However, two bridge restressings were performed due to excessive bar force loss.

Library ID: 06-0032

Title: **Field Performance of Timber Bridges 13. Mohawk Canal Stress-Laminated Bridge**

Author: Paula D. Hillbrich Lee, Xanthi Lauderdale

Publisher: USDA Forest Service, FPL

Year Published: 1997 Number of Pages: 18

URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp563.pdf

The Mohawk Canal bridge was constructed in August 1994, just outside Roll, Arizona. It is a simple-span, double-lane, stress-laminated deck superstructure, approximately 6.4 m (21 ft) long and 10.4 m (34 ft) wide and constructed with Combination 16F-V3 Douglas Fir glued-laminated timber beam laminations. The performance of the bridge was monitored continuously for 2 years, beginning shortly after installation. Performance monitoring involved gathering and evaluating data relative to the moisture content of the wood deck, the force level of the steel stressing bars, the vertical creep of the deck, and the behavior of the bridge under static load conditions. Furthermore, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing properly with no structural deficiencies.

Library ID: 06-0033

Title: **Field Performance of Timber Bridges 14. Dean, Hibbsville, and Decatur Stress-Laminated Deck Bridges**

Author: Paula D. Hilbrich Lee, Michael A. Ritter, Steve Golston, Keith Hinds

Publisher: USDA Forest Service, FPL

Year Published: 1997 Number of Pages: 21

URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp564.pdf

The Dean, Hibbsville, and Decatur bridges were constructed in southern Iowa during 1994. Each bridge is a simple-span, stress-laminated deck superstructure, approximately 7.3 m (24 ft) long, constructed from eastern cottonwood lumber. The performance of each bridge was monitored for approximately 2 years, beginning shortly after installation. Monitoring involved collecting and evaluating data pertaining to the moisture content and vertical creep of the wood decks, the force level of the stressing bars, and the behavior of the bridges under static load conditions. In addition, comprehensive visual inspections were conducted to assess the overall conditions of the structure. Based on field evaluations, the bridges are performing well with minor serviceability deficiencies.

Library ID: 06-0034

Title: **Field Performance of Timber Bridges 12. Christian Hollow Stress-Laminated Box-Beam Bridge**

Author: James P. Wacker, Stephen C. Catherman, Richard G. Winnett

Publisher: USDA Forest Service, FPL

Year Published: 1998 Number of Pages: 17

URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp560.pdf

In January 1992, the Christian Hollow bridge was constructed in Steuben County, New York. The bridge is a single-span, stress-laminated box-beam superstructure that is 9.1 m long, 9.8 m wide, and 502 mm deep (30-ft long, 32-ft wide, and 19-3/4 in deep). The performance of the bridge was continuously monitored for 28 months, beginning shortly after installation. Performance monitoring involved gathering and analyzing data relative to the wood moisture content, force level in the stressing bars, vertical bridge creep, and behavior under static load conditions. In addition, comprehensive visual inspections were conducted to assess the condition of the overall structure. Based on field evaluations, the bridgeis performing well with no structural or serviceability deficiencies.

Library ID: 06-0035

Title: **Field Performance of Timber Bridges 15. Pueblo County, Colorado, Stress-Laminated Deck Bridge**

Author: Lola E. Hislop

Publisher: USDA Forest Service, FPL

Year Published: 1998 Number of Pages: 19
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp566.pdf

The Pueblo County 204B bridge was constructed in March 1990 in Pueblo, Colorado, as a demonstration bridge under the USDA Forest Service Timber Bridge Initiative. The stress-laminated deck superstructure is approximately 10 m long, 9 m wide, and 406 mm deep, with a skew of 10 degrees. Performance monitoring was conducted for 3 years, beginning at installation, and involved gathering data on the moisture content of the wood deck, the force level of the stressing bars, the behavior of the bridge under static load conditions, and the overall condition of the structure. In addition, long-term performance data were gathered on the force level of the stressing bars 6 years after installation. Based on monitoring evaluations, the bridge is performing well, with some crushing of the bearing plates into the outside laminations but no other structural or serviceability deficiencies.

Library ID: 06-0036

Title: **Field Performance of Timber Bridges 16. North Siwell Road Stress-Laminated Bridge**

Author: James A. Kainz

Publisher: USDA Forest Service, FPL

Year Published: 1998 Number of Pages: 17
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp570.pdf

The North Siwell Road bridge was constructed during December 1994 in Hinds County, Mississippi. The bridge is a single-span, stress-laminated T-beam structure that measures 9.1 m (30 ft) long and 8.7 m (28.5 ft) wide. Performance of the bridge was monitored for 24 months, beginning at the time of installation. Monitoring involved gathering and evaluating data relative to the moisture content of the wood components, force level of stressing bars, and behavior of the bridge under static load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well.

Library ID: 06-0037

Title: **Field Performance of Timber Bridges 17. Ciphers Stress-Laminated Deck Bridge**

Author: James P. Wacker, James A. Kainz, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1998 Number of Pages: 16
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp572.pdf

In September 1989, the Ciphers bridge was constructed within the Beltrami Island State Forest in Roseau County, Minnesota. The bridge superstructure is a two-span continuous stress-laminated deck that is approximately 12.19 m long, 5.49 m wide, and 305 mm deep (40-ft long, 18-ft wide, and 12-in deep). The bridge is one of the first to utilize red pine sawn lumber for a stress-laminated deck application. The performance of the bridge was monitored continuously for 24 months beginning July 1993, approximately 46 months after installation. Performance monitoring involved evaluating data relative to the moisture content of the wood deck, the force level of stressing bars, and the behavior of the bridge under static load conditions. In addition, temperatures were collected from the bridge superstructure and ambient air. Based on field evaluations, the Ciphers bridge is performing satisfactorily with no structural or serviceability deficiencies.

Library ID: 06-0038

Title: **Field Performance of Timber Bridges 18. Byron Stress-Laminated Truss Bridge**

Authors: Habib J. Dagher, Frank M. Altimore, Vincent Caccese, Michael A. Ritter

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 20
URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp588.pdf

Library ID: **06-0038 *cont.***

The Bryon bridge was constructed in the fall of 1993 in Bryon, Maine. The bridge is a single-span, two-lane, stress-laminated truss structure approximately 46 feet long and 32 feet wide. The truss laminations were produced using chromated copper arsenate (CCA) treated southern pine connected with metal plate connectors. This report includes information on the design, construction, and field performance of the bridge. Field performance was monitored for approximately 5 years, beginning shortly after bridge construction. Performance monitoring involved collecting and evaluating data relative to wood moisture content, force level of stressing bars, behavior under static truck loading, and overall structural condition. The field evaluations showed that the Bryon bridge is performing well, with no structural or serviceability deficiencies.

Library ID: 06-0039

Title: **Field Performance of Timber Bridges: 19. North Yarmouth Stress-Laminated Truss Bridge**

Author: Habib J. Dagher, Frank M. Altimore, Vincent Caccese, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 19

URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp590.pdf

The North Yarmouth bridge was constructed in the spring of 1994 in North Yarmouth, Maine. The bridge is a single-span, two-lane, stress-laminated truss structure that is approximately 39 feet long and 32 feet wide. The truss laminations were produced using chromated copper arsenate (CCA) treated southern pine connected with metal plate connectors. This report includes information on the design, construction, and field performance of the bridge. Performance of the bridge was monitored for approximately 4 years, beginning shortly after bridge construction. During the field monitoring program, data were collected related to the wood moisture content, the force level of the stressing bars, behavior under static truck loading, and overall structural condition. Based on 4 years of field evaluations, the bridge is performing well with no structural or serviceability deficiencies.

Library ID: 06-0040

Title: **Field Performance of Timber Bridges 20. Gray Stress-Laminated Deck Bridge**

Authors: Habib J. Dagher, Frank M. Altimore, Vincent Caccese, Michael A. Ritter, Richard Hebert

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 15

URL: http://www.fpl.fs.fed.us/documnts/fplrp/fplrp592.pdf

The Gray bridge was constructed in the fall of 1991 in Gray, Maine. The bridge is a single-span, two-lane, stress-laminated deck structure that is approximately 24 foot long and 23 foot wide. It was constructed from CCA-treated eastern hemlock grown in Maine. This report presents information on the design, construction, and field performance of this bridge. The field performance of the bridge was monitored for 6-1/2 years, beginning shortly after construction. During the field monitoring program, data were collected related to wood moisture content, force level of stressing bars, behavior under static truck loading, and overall structural condition. With the exception of having to be retensioned approximately every 3 years, the bridge is performing well, with no structural or serviceability deficiencies.

Library ID: 06-0041

Title: **Analysis of Thermal Change in Stress-Laminated Timber Bridge Decks**

Author: James A. Kainz, James P. Wacker, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 9

As the timber bridge design has evolved, some engineers have been concerned about the integrity of the stress-laminated bridge depends on the level of interlaminar compression (between the wood laminations). Temperature change can cause material shrinkage, which could lead to substantial performance problems based on material mechanics and the nature of the stress-laminated system. In this study, to determine the effects of thermal change on interlaminar compression, four stress-laminated timber deck sections were put through a warm-cold-warm cycle. Various interlaminar stress levels and three moisture content levels were tested. Results showed that interlaminar compression in stress-laminated decks of this size was not affected by extremely cold temperatures when the moisture content was less than 19 percent and when initial bar force was sufficient.

Section 06 — Monitoring and Performance *cont.*

Library ID: 06-0042

Title: **Field Performance of Timber Bridges: 21. Humphrey Stress-Laminated T-Beam Bridge**

Author: James A. Kainz, James P. Wacker, Michael A. Ritter, Stan Bishop

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 16

The Humphrey bridge was constructed during the summer and fall of 1993 in Cattaraugus County, NY. The bridge is a single-span, stress-laminated T-beam structure that measures 14.1 m (48.6 ft) long and 10.2 m (33.5 ft) wide. Performance of the bridge was monitored for 35 months, beginning approximately 8 months after installation. Monitoring involved gathering and evaluating data relative to the moisture content of the wood components, force level of the stressing bars, and behavior of the bridge under static load conditions. In addition, comprehensive visual inspections were conducted to assess the overall condition of the structure. Based on field evaluations, the bridge is performing well, with only a few minor serviceability issues.

Section 07 — Materials

Library ID: 07-0001

Title: **Evaluation of Yellow-Poplar Glued-Laminated Timber Beams**

Author: Roland Hernandez, Somnath Sharma Sonti, Russell C. Moody

Publisher: American Society of Agricultural Engineers

Year Published: 1992 Number of Pages: 11

Although yellow-poplar is not currently used in structural glued-laminated (glulam) timber construction, its properties suggest that it may be feasible for this purpose. Using this species, we developed glulam beam combinations that achieved a target design bending stress (Fbx) of 16.5 Mpa (2,400ln/ in2) and modulus of elasticity of 12.4 Gpa (1.80x10 6lb/in 2). The glulam combinations were designed with E-rated lumber grades in the outer laminations (top and bottom) and No. 2 grade lumber in 50 percent of the center laminations. Results of tests on 45 glulam beams met the target design levels, indicating that this species is a feasible candidate for structural glulam construction.

Library ID: 07-0002

Title: **Performance of Red Maple Glulam Timber Beams**

Author: Harvey B. Manbeck, John J. Janowiak, Paul R. Blankenhorn, Peter Labosky, Russell C. Moody, Roland Hernandez

Publisher: USDA Forest Service, FPL

Year Published: 1993 Number of Pages: 30

A red maple glued-laminated (glulam) beam combination that would achieve a design bending stress of 2,400 lb/in2 (16.5 Mpa) and modulus of elasticity of 1.8 x 10 6 lb/in2 (12.4 Gpa) was developed; 45 beams were evaluated. The properties of the lumber grades used in the lay-up and their placement within the beams were closely monitored during beam fabrication. Another 166 specimens of end-jointed lumber were gathered during manufacture to relate the individual tensile strength performance of end joints to their performance in the beams. The evaluations of the end-jointed specimens and the full-sized beams indicate that a glulam beam combination with the targeted design stress in bending and modulus of elasticity is possible.

Library ID: 07-0003

Title: **Applications of Wood Materials for Innovative Bridge Systems**

Author: Russell C. Moody, Michael A. Ritter, Hota GangaRao

Publisher: American Society of Civil Engineers

Year Published: 1990 Number of Pages: 10

Library ID: **07-0003 *cont.***

This paper describes completed research and the status of research underway on timber bridges that are part of the USDA Forest Service timber bridge initiative. The initiative includes a research and technology transfer program to develop new and improved bridge systems and increase awareness of the attributes of timber. Research on material properties, preservative treatments, and innovative system development is included, and programs are underway at several universities in the United States, many of which are cooperating with the Forest Products Laboratory.

Library ID: 07-0004

Title: **Yield of 2 by 4 Red Oak Stress-graded Dimension Lumber from Factory-grade Logs**

Author: Kent A. McDonald, James W. Whipple

Publisher: Forest Products Research Society

Year Published: 1992 Number of Pages: 6

Efficient conversion of red oak logs to structural dimension lumber depends on knowledge about the expected yield from different grades of logs. Our results show that nominal 2 by 4 inch (standard 38 by 89 mm) dimension-lumber yields from USDA Forest Service construction-grade logs are greater than yields from USDA factory-grade F3 logs. Comparable yields of dimension lumber were obtained from factory-grade F2 and construction-grade log classes. Market competition for the higher valued factory-grade F2 log for factory lumber indicates that only logs from the construction-grade class should be considered only with caution.

Library ID: 07-0005

Title: **Investigation of the Mechanical Properties of Red Oak 2 By 4's**

Author: David W. Green, Kent A. McDonald

Publisher: USDA Forest Service, FPL

Year Published: 1993 Number of Pages: 11

Efficient utilization of hardwood structural lumber depends on developing better procedures of grading and property assignment. In this study, we evaluated the properties of red maple 2 by 4 inch (standard 38 by 89 mm) lumber tested in bending and in tension and compression parallel to the grain and compared the results to published values derived by ASTM D 245 clear wood procedures. The results indicate that significant increases in allowable properties could be obtained using procedures based on tests of full-size lumber. The results also demonstrates that the relationships between tension parallel to grain and bending strength are similar to those for softwood species. Thus, procedures used to assign properties to mechanically graded softwood species should be applicable to red maple.

Library ID: 07-0006

Title: **Stress Class Systems: An Idea Whose Time Has Come?**

Author: David W. Green, David E. Kretschmann

Publisher: USDA Forest Service, FPL

Year Published: 1990 Number of Pages: 22

Stress class systems are species-independent grade classification systems for structural lumber. They are used throughout the world to reduce the number of species and grade choices that face the designer of engineered wood products. Stress class systems offer an opportunity to simplify lumber specification in the United States and to encourage more uniform quality standardization across product types. This report describes the major stress class systems used in Europe and the Pacific Rim countries and discusses the advantages and disadvantages of these systems. In addition, an alternative stress class system for use in the United States is proposed. It is recommended that development of a U.S. stress class system should be a consensus effort, involving the lumber industry, industry user groups, and design engineers.

Library ID: 07-0007

Title: **Behavior of Metal-plate Connected Joints in Creosote Treated Wood: A Pilot Study**

Author: M. G. Oliva. L. Krahn, M. McCarthy, M. Ritter

Publisher: Forest Products Research Society

Year Published: 1988 Number of Pages: 5

Library ID: **07-0007 *cont.***

A small series of joints was examined to determine whether toothed metal connector plates (truss plates) could be successfully used to connect creosote treated wood members. Three types of joints, one with untreated wood and two with treated wood, were load-tested to qualitatively determine if the treatment affected either the strength of stiffness of the joints. The creosote treatment actually resulted in either similar or increased joint capacity and stiffness when compared to untreated wood. The results of this pilot study indicate that the use of metal connector plated in creosote treated wood may be feasible. Additional comprehensive studies should be undertaken to determine quantitative effects as well as the corrosion resistance of the plate in environmental conditions or when subjected to road salts.

Library ID: 07-0011

Title: **Experimental Shear Strength of Glued-Laminated Beams**

Author: Douglas R. Rammer, Lawrence A. Soltis

Publisher: USDA Forest Service, FPL

Year Published: 1994 Number of Pages: 38

Current shear design specifications ignore the effects of beam size. The ASTM D245 adjustment that relates ASTM D143 shear block results to design shear strength is unclear. An experimental study was conducted to determine shear and bending strength of matched Southern Pine and Douglas-fir glued laminated beams. A five-point loading setup determined beam shear strength values. These strength values were compared with the results of small, clear ASTM D143 specimens cut from the failed beam shear specimens. Bending strength was determined by third-point loading beam tests. Statistical methods of regression and analysis of variance investigated the following possible correlation's: shear strength to beam size, shear strength to bending strength, and beam shear strength to ASTM shear block strength. Results from study indicate that (1) a five-point test setup can consistently produce beam shear failures from a wide range of beam sizes, (2) no apparent correlation exists between modulus of rupture and shear strength, (3) shear strength is dependent on beam size, and (4) beam shear strength is related to ASTM D143 shear strength values provided the re-entrant corner stress-concentration effects are considered.

Library ID: 07-0012

Title: **Production of Hardwood Machine Stress Rated Lumber**

Author: David W. Green, Robert J. Ross, and Kent A. McDonald

Publisher: Forest Products Society

Year Published: 1994 Number of Pages: 10

There is considerable interest in using hardwood species in engineered structures. Recently the USDA Forest Products Laboratory (FPL) conducted a series of laboratory and field studies to examine use of mechanical grading procedures to enhance the use of hardwoods for structural lumber. Our first laboratory efforts revealed that for most domestic hardwood species the relationships between bending strength and the strength in tension and compression parallel to the grain is similar to those for softwood species. Thus, the procedures used to assign allowable design properties to machine stress rated (MSR) lumber are also applicable to hardwood species. Further research at the FPL and West Virginia University showed that significantly higher properties could be obtained through mechanical grading of red oak than is currently possible through visual grading. These encouraging results prompted us to conduct a demonstration study of machine stress rating of hardwood lumber at the Spencer, W. Va. division of the Burke-Parsons-Bowlby Corp. Using the transverse vibration technique to measure modulus of elasticity (MOE), 800 2 by 8s were graded as 1650f-1.4E MSR lumber by the Northeastern Lumber Manufacturer's Association with the assistance of the Southern Pine Inspection Bureau. The lumber was used to construct a 40-foot span timber bridge in Jackson County, WV.

Library ID: 07-0013

Title: **Yellow-Poplar Glulam Timber Beam Performance**

Author: Russell C. Moody, Roland Hernandez, Julio F. Davalos, Somnath Sharma Sonti

Publisher: USDA Forest Service, FPL

Year Published: 1993 Number of Pages: 28

Yellow-Poplar is currently not used in structural glued-laminated (glulam) timber construction, but its properties suggest that it may be feasible for this purpose. Using Yellow-Poplar, we designed glulam beam combinations to target bending stresses of 2,400 lb/in^2 and modulus of elasticity of 1.8 x 10^6 lb/in^2. The glulam combinations were designed with E-rated lumber grades in 25 percent of the outer laminations (top and bottom) and No. 2 grade lumber in 50 percent of the center laminations. In addition to evaluating 45 full-sized beams, more than 200 end-jointed lumber specimens were tested in tension to compare individual specimen performance to full-size beam performance. Results for the Yellow-Poplar glulam beams met the target design levels, indicating that this species is a feasible candidate for structural glulam construction.

Library ID: 07-0014

Title: **Mechanical Properties of Red Maple Structural Lumber**

Author: David W. Green, Kent A. McDonald

Publisher: USDA Forest Service, FPL

Year Published: 1993 Number of Pages: 15

Efficient utilization of hardwood structural lumber depends on developing better procedures of grading and property assignment. In this study, we evaluated the properties of red maple 2 by 4 inch (standard 38 by 89 mm) lumber tested in bending and in tension and compression parallel to the grain and compared the results to published values derived by ASTM D 245 clear wood procedures. The results indicate that significant increases in allowable properties could be obtained using procedures based on tests of full-size lumber. The results also demonstrate that the relationships between tension parallel to grain and bending strength are similar to those for softwood species. Thus, procedures used to assign properties to mechanically graded softwood species should be applicable to red maple.

Library ID: 07-0015

Title: **Hardwood Structural Lumber From Log Heart Cants**

Author: Kent A. McDonald, Curt C. Hassler, Jack E. Hawkins, Timothy L. Pahl

Publisher: Forest Products Society

Year Published: 1996 Number of Pages: 8

Expected cost advantages of using hardwood for bridge superstructures rather than steel and concrete have not been evident. Some reasons given include the use of red oak, which is in high demand for other uses, and the fact that the hardwood dimension lumber market is not established. Another reason is that the lumber supply is coming from the high-grade outer portion of oak logs. In this study, we explored the potential for producing hardwood bridge products from log heart cants, including railroad ties and pallet cants. The report evaluates that availability of cant material from West Virginia mills and structural-grade dimension lumber from ties and cants for several species: red oak, hickory, red maple, yellow-poplar, beech, and white oak.

Library ID: 07-0016

Title: **Fiber Stress Values for Design of Glulam Timber Utility Structures**

Author: Roland Hernandez, Russell C. Moody, Robert H. Falk

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 25

In this study, we developed a simple equation to calculate average fiber stress values for design of glued-laminated (glulam) timber utility structures as a function of design bending stress. We took design stress in bending values specified by the American Institute of Timber Construction (AITC) for various combinations of glulam timber, applied appropriate end-use adjustments and determined an appropriate factor to obtain average modulus of rupture. Fiber stresses for glulam were then determined from the average modulus of rupture values using the relationship between these values and the fiber stress values for round timber poles. To verify this relationship, a data base was compiled that obtained bending strength results of glulam timber beams manufactured following the design combinations established by AITC. Results indicate that the proposed equation can be used to calculate fiber stresses for all glulam beams manufactured with visually graded or E-rated lumber. For bending members less than 50 ft (15.24 m) long, the average fiber stress was found to be approximately 2.7 times the design stress in bending.

Library ID: 07-0017

Title: **Western Hardwoods, Value-Added Research and Demonstration Program**

Author: David Green, William von Segen, Susan Willits

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 43

Library ID: **07-0017 *cont.***

Research results from the value-added research and demonstration program for western hardwoods are summarized in this report. The intent of the program was to enhance the economy of the Pacific Northwest by helping local communities and forest industries produce wood products more efficiently. Emphasis was given to value-added products and barriers to increased utilization. The program was coordinated by the Pacific Northwest Research Station, the Pacific Northwest Region of State and Private Forestry, and the Forest Products Laboratory.

Library ID: 07-0018

Title: **Probabilistic Modeling of Yellow-poplar Glued-laminated Timber**

Author: Roland Hernandez

Publisher: American Society of Agricultural Engineers

Year Published: 1993 Number of Pages: 11

A Monte Carlo simulation model, PROLAM, was used to simulate the performance of glued-laminated (glulam) timber beams manufactured from yellow-poplar lumber. Mechanical properties of tested lumber and finger joints were analyzed to determine the input properties required by the model. Due to the presence of censored data (unfailed tension test specimens), only one beam group was analyzed. Monte Carlo simulation procedures were used to compile and characterize bending strength and stiffness distributions of the yellow-poplar glulam timber beams. Results of the SIMULATED 8-lamination yellow-poplar glulam beams were within 2% of the TEST results for both MOE and MOR.

Library ID: 07-0019

Title: **Red Maple Stress-graded 2 by 4 Dimension Lumber from Factory-grade Logs**

Author: Kent A. McDonald, David W. Green, Jack Dwyer, James W. Whipple

Publisher: Forest Products Society

Year Published: 1993 Number of Pages: 6

Conversion of red maple logs into profitable products, including structural dimension lumber, depends on knowledge about the expected yield from different qualities of logs. Results of this study reveal a high yield of nominal 2 by 4 inch (standard 38 by 89 mm) lumber that meets or exceeds the light-frame grade criteria from USDA Forest Service factory-grades F2 and F3, was graded structural lumber. The underutilized red maple timber resource could supply a structural lumber product demand for residential housing markets and nonresidential construction such as timber bridges. However, improved methods are needed to sort logs into quality classes to be used in production of structural lumber.

Library ID: 07-0020

Title: **Guidelines for Producing Hardwood Structural Lumber for Glulam Production**

Author: John Janowiak, Jeff Kimmel

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 6

URL: http://www.fs.fed.us/na/wit/pdf/WIT-07-0020.pdf

General structural grading guidelines are provided to hardwood sawmill manufacturers interested in producing hardwood structural material.

Library ID: 07-0021

Title: **Chestnut Oak: Qualification & Outcomes for Use in a Glulam Timber Bridge**

Authors: Jeffrey D. Kimmel, John J. Janowiak

Publisher: The Pennsylvania State University

Year Published: 2000 Number of Pages: 7

Chestnut oak lumber was analyzed to identify whether it could be used economically and structurally in glulam timber bridge applications in Pennsylvania.

Section 07 — Materials *cont.*

Library ID: 07-0022

Title: **Defect Characterization and Recovery of Dimension Glulam Lamination Stock From Non-Stress Rated Red Maple Lumber Supplies**

Authors: Jeffrey D. Kimmel, John J. Janowiak

Publisher: The Pennsylvania State University

Year Published: 2000 Number of Pages: 36

This report provides the results of a study that focused on: 1.) developing a systematic approach that enables a glulam fabricator, independent of a sawmill supply source, to conduct visual stress-rating (VSR), and/or mechanical E-rating of hardwood lumber; 2.) characterize defect and recovery information about hardwood dimension lamination stock; and 3.) compile and prepare a summary of the process requirements that hardwood sawmills must be aware of to produce nominal dimension lumber products that are acceptable to glulam manufacturers for application to glued-laminated timber bridge projects.

Library ID: 07-0023

Title: **Standard for Mechanically Graded Hardwood Lumber**

Authors: A. L. DeBonis

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 63

This publication proposes a standard for mechanically grading lumber for use in timber bridge applications. Before the standard is implemented, it must go through a full evaluation. This evaluation has not yet been completed.

Section 08 — Contacts

Library ID: 08-0001

Title: **Wood In Transportation: Timber Bridge Information Contacts Report of Project Funded Bridges 1989-1995**

Author: NWITIC

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1996 Number of Pages: 11

The Wood In Transportation Program has funded 349 vehicular and pedestrian demonstration bridges throughout the United States. A data base of information is being kept of participants in The Timber Bridge Demonstration Program for each funded bridge. The report summarizes the information in a regional format, categorized by engineers, fabricators, wood preservers, and erectors, which is a listing of participants in timber bridge projects funded by the Timber Bridge Initiative for the years 1989 through 1995. The list is not a comprehensive list of people and business familiar with timber bridge construction; however, it is meant to be used as a means for individuals to obtain local and regional information on timber bridge construction in their area of the country.

Library ID: 08-0002

Title: **American Institute of Timber Construction: Membership List**

Author: AITC

Publisher: AITC

Year Published: 1994 Number of Pages: 1

This is a listing of active members of the American Institute of Timber Construction (AITC) who manufacture structural glued-laminated (glulam) timber.

Library ID: 08-0003

Title: **Contacts Information for Glulaminated Timber Bridges**

Author: NWITIC

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 1

URL: http://www.fs.fed.us/na/wit/pdf/glulam~1.pdf

Companies listed below have participated, or are participating, in the USDA Forest Service's Wood In Transportation program, formerly known as the National Timber Bridge Initiative. These companies have supplied, or will supply, glulaminated vehicular bridges for various demonstration projects throughout the country. They should be able to provide information on glulam bridge designs and costs.

Library ID: 08-0004

Title: **Contacts Information for Pedestrian and Trail Bridges**

Author: NWITIC

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 1

URL: http://www.fs.fed.us/na/wit/pdf/pedest~1.pdf

Most companies listed below have participated, or are participating, in the USDA Forest Service's Wood in Transportation Program, formerly the National Timber Bridge Initiative. These companies have supplied, or will supply, pedestrian or trail bridges for various demonstration projects throughout the country. They should be able to provide information on pedestrian and trail bridge designs and costs.

Section 09 — Markets

Library ID: 09-0001

Title: **The Potential of Producing Prefabricated, Modern Timber Bridge Components in Mississippi**

Author: T. Amburgey, L. Breazeale, R. Daniels, P.C. McLaurin, Jr., S. Murray, L. Reinschmiedt, R. Sinno, P.H. Short, D. Trammell, Jr.

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1994 Number of Pages: 56

This study examines the potential of manufacturing prefabricated, modern timber bridge components in Mississippi. Estimated manufacturing costs, estimated total economic impact, and information supplemental to detailed economic feasibility study are presented.

Library ID: 09-0002

Title: **Factors Influencing the Adoption of Timber Bridges: The Role of New Technology Adoption in the Timber Bridge Market**

Author: Robert L. Smith, Robert J. Bush

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1995 Number of Pages: 41

This publication provides the background, justification, and states the objectives for the development of a five-part marketing analysis of timber bridges. This is Part I; a literature review of technological advance in modern timber bridges, perceptions of decision makers, and those marketing factors which influence timber bridges in the marketing arena. It describes the industrial innovation process and barriers to the adoption of new products. It concludes with a discussion of the decision-making process and the Analytical Hierarchy Process.

Library ID: 09-0003

Title: **A Perceptional Investigation into the Adoption of Timber Bridges: The Role of New Technology Adoption in the Timber Bridge Market**

Author: Robert L. Smith, Robert J. Bush

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1995 Number of Pages: 21

Perceptions of major bridge materials by four distinct groups of decision makers were investigated within five geographic regions of the United States. Timber was rated lowest in perceived performance within each group and region. Timber was compared to prestressed concrete, steel, and reinforced concrete on eight pre-selected attributes. Timber was rated lowest on the attributes of Low maintenance, Easy to design, Long life, and High strength. Only on the attribute of Easy to construct did timber rate above reinforced concrete. In all cases, timber never rated higher than prestressed concrete on any attribute. Highway officials who have participated in the Timber Bridge Initiative rated timber as a bridge material statistically higher in overall performance than those highway officials who have not participated in the program. Marketing strategies are suggested for the timber bridge industry.

Library ID: 09-0004

Title: **A Hierarchical Analysis of Bridge Decision Makers: The Role of New Technology Adoption in the Timber Bridge Market**

Author: Robert L. Smith, Robert J. Bush

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1995 Number of Pages: 22

Bridge design engineers and local highway officials make bridge replacement decisions across the United States. The Analytical Hierarchy Process was used to characterize the bridge material selection decision of these individuals. State Department of Transportation engineers, private consulting engineers, and local highway officials were personally interviewed in Mississippi, Virginia, Washington, and Wisconsin to identify how important factors determine their choice of a bridge material selection decision for different groups of decision makers. Based on the importance of various decision criteria and how well the material alternatives (steel, reinforced concrete, prestressed concrete, and timber) meet them, strategies are recommended for those promoting timber as a bridge material.

Library ID: 09-0005

Title: **Marketing Practices in the Timber Bridge Industry: 1993 The Role of New Technology Adoption in the Timber Bridge Market**

Author: Robert L. Smith, Robert J. Bush

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1995 Number of Pages: 16

Timber bridge manufacturers across the United States were surveyed to establish a base of information concerning current management and marketing practices. Forty-three percent of the firms studied were concentrated in the West, and less than one-third of the bridge companies were located in the South, Mid-Atlantic, and Northeast. Total sales of companies promoting timber bridge ranged from 1.2 million to over 2 billion dollars; however, average timber bridge sales accounted for only 7% of total sales. Wood treating and glue-laminating timber firms represented over 75% of reporting companies. Responding bridge firms rated state Department of Transportation employees as most important in the bridge decision and local highway officials as least important. Statistical differences existed between timber bridge firms and highway officials based on importance of factors in the bridge material decision. Bridge companies felt that timber bridge sales would increase by an average of 7.5% over the next 5 years.

Library ID: 09-0006

Title: **A Strategic Evaluation of Factors Affecting the Adoption of Timber Bridges: The Role of New Technology Adoption in the Timber Bridge Market**

Author: Robert L. Smith, Robert J. Bush

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1995 Number of Pages: 22

Library ID: **09-0006 cont.**

A comprehensive study was undertaken to determine the barriers and incentives that continue to exist for timber bridge adoption across the United States. The study began with a comprehensive literature search of secondary information in the areas of timber bridges, innovation, barriers to entry of new products, and decision-making theory. Input was sought from qualified industry and university personnel.

Library ID: 09-0007

Title: **Manufacturing and Marketing Opportunities for Modern Timber Bridges in Michigan**

Author: Jack Pilon, Dan Sikarskie, Roger Rasmussen, Russell Kidd

Publisher: MI DOT, MI RC&D, MI DNR - Forest Mang. Div., MI DNR - Land & Water Mang. Div., MI State Univ. Ext., USDA Forest Service, NA-S&PF

Year Published: 1995 Number of Pages: 17

This report discusses the manufacturing and marketing opportunities for modern timber bridges in Michigan.

Library ID: 09-0008

Title: **Timber Bridge Potential in the State of Wisconsin**

Author: Lumberjack RC&D, River Country RC&D, Golden Sands RC&D, Southwest Badger RC&D, Pri-Ru-Ta RC&D

Publisher: George Banzhaf and Company

Year Published: 1994 Number of Pages: 83

This report discusses the timber bridge potential in the state of Wisconsin.

Library ID: 09-0009

Title: **Decision Maker Perceptions of Timber Bridges in the United States**

Author: Bob Smith and Robert J. Bush

Publisher: Center for Forest Products Marketing, VA Tech.

Year Published: 1994 Number of Pages: 4

Bridge engineers and highway officials were surveyed to determine their perceptions of timber as a bridge material. When compared to other common bridge materials, timber was consistently rated lower in performance. However, it appears that many respondents based their perceptions on outdated bridge designs. Concerns with timber focused on maintenance, decay and life-span. Currently accepted applications of timber bridges appear limited to low volume, short-span bridges on rural roads and where aesthetics are of high importance. Factors influential in the decision making process were identified and strategies proposed by which timber bridge manufacturers may increase the effectiveness of their marketing strategies.

Library ID: 09-0010

Title: **The Identification of Market Opportunities for Wood in the United States Transportation System, The Role of New Technology Adoption in the Timber Bridge Market: Special Project Fiscal Year 1994**

Author: Warren Spradlin, Robert L. Smith

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1996 Number of Pages: 30

URL: http://www.fs.fed.us/na/wit/pdf/WIT-09-0010.pdf

This publication examines current consumers of wood products in the United States' four transportation systems: the highway system, the railroad system, the marine and waterway system, and the electricity and communications transportation system. The study investigates how these consumers chose their infrastructure materials, and it determines if there are ways to influence their decisions on the materials they utilize.

Library ID: 09-0013

Title: **Role of Intermediaries in Technology Transfer in the Logging Industry: A Case Study with Portable Timber Bridges**

Author: Ren-Jye Shiau, Robert L. Smith, Edward T. Cesa

Publisher: Forest Products Society

Year Published: 2001 Number of Pages: 8

Intermediaries in the logging industry were surveyed to evaluate their role in the transfer of technology. These individuals play the important role of transferring information from developers of technology to the potential users of technology. Intermediaries, pre-identified by loggers, included state agencies (foresters), industry foresters, marketing professionals in private companies, officers in trade associations, and extension specialists. This study identified that intermediaries from different professional groups have different preferred sources for learning about new technology, effective methods for disseminating new information, factors influencing their decisions to disseminate new information, and factors in the promotion of portable timber bridges. It is very difficult to develop a unified channel strategy to fit every intermediary. However, understanding the differences among those intermediaries is essential in order to promote portable timber bridge technology. Overall, personal visits, trade shows, short courses, and workshops were preferred by respondents in terms of effective methods for disseminating new technology information. The Internet was rated lowest.

Library ID: 09-0014

Title: **Potential for Expanding Small-Diameter Timber Market: Assessing Use of Wood Posts in Highway Applications**

Author: Dorothy Paun, Gerry Jackson

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 28

Because of a combination of circumstances, there is an over-abundance of small-diameter timber available in the United States. There is low demand for this material because it has low value. One way to increase the value, and therefore the demand, for this material is to develop or expand markets where the material can be used. We looked at markets where little or no machining would be required before use because this would make it more feasible to use small-diameter material. One such market is that of wood posts in highway applications. In this study, we gathered information on the current use of posts, both wood and those made from other materials, used in highway applications. Information was gathered using a survey of Department of Transportation engineers from across the United States. We then analyzed the information to assess the possibility of increasing the use of small-diameter timber in the highway application market. We found many opportunities for ways this market could be expanded, but we also found challenges to increasing this market.

Library ID: 10-0001

Title: **Wood In Transportation - Superstructure Costs Report for Vehicular Timber Bridges 1989-1995**

Author: NWITIC

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1996 Number of Pages: 5

URL: http://www.fs.fed.us/na/wit/pdf/crossi~1.pdf

The Wood In Transportation Program, formerly called the National Timber Bridge Initiative, began funding demonstration timber bridges in fiscal Year 1989. Since the beginning of the program, 349 demonstration vehicular and pedestrian timber bridges and 58 special projects have been funded in 48 states. The purpose of this report is to provide information on the superstructure costs of vehicular timber bridges funded through the Wood In Transportation Program. This report focuses on the final cost data that the Timber Bridge Information Resources Center (TBIRC) has for vehicular timber bridges. The final cost data is supplied by our cooperators, and the cost averages in this report are represented by region, bridge type, length, and species.

Library ID: 10-0004

Title: **Modern Timber Bridges in Mississippi: An Examination of Critical Issues**

Authors: B. Daniels, P.H. Short, T.L. Amburgey, H. M. Barnes, V. Gulver, K. Hood

Publisher: Mississippi State University

Year Published: 1995 Number of Pages: 48

This study examines two critical issues concerning the development of a modern timber bridge manufacturing industry in Mississippi. A detailed discussion of site-specific cost comparisons of modern timber bridges and concrete bridges is the focus of the first critical issue. The intent of this study was to provide critical information needed to develop a rationale for changing current policy, which would allow modern timber bridges to compete for State Aid bridge funds of Mississippi.

Library ID: 10-0005

Title: **Timber Bridge Economics**

Authors:

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 40

Interest in timber bridges has grown rapidly in recent years as a result of new technologies in design and construction as well as advances in material manufacturing and preservative treatments. Despite these advances, little is known about the initial and life-cycle costs of timber bridges relative to those of other construction materials. The objectives of this study were to evaluate the cost characteristics of timber bridges and to compare the initial cost of timber bridge superstructure with that of bridges constructed of steel, concrete, and prestressed concrete. For timber bridges, results show a relationship between cost per square foot and bridge length, load rating, and geographic location. In general, timber bridge superstructures tended to compete with steel and concrete bridge superstructures on an initial cost basis. However, the range in cost per square foot values for all bridges varied widely. This outcome was probably due to both the high variability in these data and the relatively small sample size of the data sets for steel and concrete.

Library ID: 11-0001

Title: **Development of a Six-Year Research Needs Assessment for Timber Transportation Structures**

Author: Terry J. Wipf, Michael A. Ritter, Sheila Rimal Duwadi, Russell C. Moody

Publisher: USDA Forest Service, FPL

Year Published: 1993 Number of Pages: 44

A timber bridge, once a thing of the past, is now becoming a thing of the present. Interest in timber bridges and other transportation structures has been rapidly increasing. Much of this is due to new technologies in design and construction as well as advances in material manufacturing and preservative treatments. Although timber bridges and other transportation structures are gaining in popularity, there is much to be accomplished to fully develop wood as a material for transportation structures. This report summarizes research needs determined and prioritized by public and private individuals, and groups and organizations that have a potential interest in bridges and transportation structures. These research needs are categorized into research areas that correspond to the categories identified in the Intermodal Surface Transportation Act of 1991, Section1039(a). Analysis of the research needs show that there is a great deal of interest in wood preservation, development of standardized procedures, guidelines and specifications, and technology transfer. The projects and priorities identified in this study will be used by the Federal Highway Administration and the USDA Forest Service, Forest Products Laboratory as a basis for developing a national 6-year research program for timber transportation structures.

Library ID: 11-0002

Title: **Timber Bridges: Part of the Solution for Rural America**

Author: Robert Brungraber, Richard Gutkowski, William Kindya, and Ruth McWilliams

Publisher: Transportation Research Board

Year Published: 1987 Number of Pages: 9

A detailed inventory of the condition of highway bridges in the United States has been prepared in recent years. The study described in this paper indicates that an overwhelming proportion of rural highway bridges are on the roads that serve low volumes of traffic. As a result of recent bridge failures and the vast number of bridges whose intended service lives have been exceeded, significant federal funding has been targeted for rehabilitation and replacement. The importance of directing an optimal proportion of funds to rural bridges is examined. The poor condition of bridges in rural regions and the impact of the problem on the rural livelihood and economy is documented. The findings of a search of the National Bridge Inventory to assess the performance and current condition of timber bridges are reported. The function that the use of contemporary timber bridges can serve in addressing the severe rural bridge restoration needs has been identified. Descriptions are provided of favorable factors that were found to pertain to both existing and recently developed timber bridge technologies. These factors provide an incentive to the continued and increase use of timber bridges. A case study in Pennsylvania is documented to profile the nature of timber bridge use and the negative impact of unattended bridge repair needs in a state with a diverse rural economy. Constraints and reservations that have existed in regard to the recent use of timber bridges in rural regions are discussed. An exhaustive program of engineering development, research, and transfer of technology that is related to a plan to significantly increase the use of timber bridges in the rural highway environment is summarized.

Library ID: 11-0003

Title: **New Ideas for Timber Bridges**

Author: Michael G. Oliva, Roger L. Tuomi, and A. G. Dimakis

Publisher: National Research Council

Year Published: 1986 Number of Pages: 6

Because nearly one-half of the bridges in the United States are listed as either functionally or structurally deficient lends impetus to search for new ideas for building and maintaining bridges. Most of these bridges are on secondary and rural roads where spans are short, which makes timber a prime candidate for construction. The Forest Service, U. S. Department of Agriculture, with a vast number of bridges under its care, is cooperating with the University of Wisconsin to investigate new techniques for timber bridge design and construction. Described in this paper are promising new ideas, which are being examined for bridge construction, rehabilitation, and production of efficient performance and low cost in timber bridge systems. The scope of the research covers reviewing recent advancements in bridge design, applying new techniques to enhance the performance of common bridge types, and evaluating totally new structural configurations for use in bridges. The performance enhancement may be achieved by increasing the transverse spread of load through distributor beams, prestressing techniques, and dowels. New structural configurations include plane trusses, multileaf trusses, and composite beams assembled together to produce parallel chord longitudinal deck systems. The research involves theoretical evaluations to estimate span capabilities. The more promising concepts, which are based on structural potential, estimated cost, and simplicity, are being experimentally tested to verify models, theory, and design procedures.

Library ID: 11-0004

Title: **Current Timber Bridge Research and Development in the United States**

Author: Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1993 Number of Pages: 10

Interest in timber bridges has increased significantly in the United States over the past 5 years. As a result, research and development related to timber bridges and the use of wood in transportation structures has also increased. Much of this research is funded through national programs that involve cooperative work with universities, local government agencies and industry organizations; however, substantial research is also sponsored by state governments and other organizations. This paper presents an overview of selected timber bridge research and development activities in progress in the United States.

Library ID: 11-0008

Title: **User Friendly Guide to Timber Bridges**

Author: Chris Donnelly

Publisher: University of New Hampshire - Continuing Education

Year Published: 1996 Number of Pages: 56

This publication serves as a brief overview of the information necessary to become acquainted with timber bridges. Its goal is to help a wide audience of builders, designers, town officials, and other decision makers as they become conversant in this sometimes simple, sometimes complex subject.

Library ID: 11-0009

Title: **Technical Note 1: Publications Listing for Wood In Transportation**

Author: James Kainz

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 6

The following is a chronological listing of publications related to cooperative Forest Products Laboratory research. This is one in a series of Technical Notes that address commonly asked questions related to Wood Transportation Structures.

Library ID: 11-0010

Title: **Research on Timber Bridges and Related Topics**

Author: Sheila Rimal Duwadi, Michael A. Ritter

Publisher: USDA Forest Service, FPL

Year Published: 1995 Number of Pages: 22

Timber bridges represent approximately 10% of the total bridges in the United States as stated in the 1994 National Bridge Inventory. In addition there are a large number of bridges classified as steel, etc. that contain timber decks. For the most part these bridges are older structures that have lasted a number of years beyond the design life of the structure. States and local authorities continue to build bridges out of wood, as wood is considered a viable material for short span structures. Although wood has been used for a number of years, there are issues that need to be addressed through research as with any other material. The primary response to these issues has been the Timber Bridge Initiative passed by Congress in 1988. More recently, Section 1039 of the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA) has included provisions for research and technology transfer into timber structures. The Timber Bridge Initiative has been charged to the USDA - Forest Service; while the ISTEA program is the responsibility of the Federal Highway Administration (FHwA).

Library ID: 11-0011

Title: **Timber Bridges - A Rebirth**

Author: Russ Moody

Publisher: Woodland Management

Year Published: 1994 Number of Pages: 3

The two bridges discussed demonstrate that red pine is a feasible structural material for glulam timber bridges. As expected, the structural properties of red pine glulam are 10 percent to 20 percent less than those of southern pine glulam. But, with known properties, engineers can design bridges that meet today's standards for highway loads. Is red pine the only Wisconsin species that can be used in timber bridges? Good question. Although it may be one of the best candidates because of its treatability, other species should not be ruled out. Many people are surprised to learn that cottonwood can be used for bridges. One bridge constructed with cottonwood was recently completed in Centerville, Iowa and several more are planned for that area. Timber bridges are not the only structural application for Wisconsin timber. With proper manufacture, grading and application, many Wisconsin species can be used for construction of houses and other structures.

Library ID: 11-0012

Title: **Wood Bridges in New England**

Author: Michael A. Ritter, Kim Stanfill-McMillan

Publisher: American Society of Civil Engineers

Year Published: 1995 Number of Pages: 4

Wood bridges in New England predate the 18th century. This paper presents an overview of history, current status, and future of wood bridges in this region. The resurgence of wood bridges is tied to economics, serviceability, and longevity. Research on new bridge designs, which are adaptable to native New England wood species, may improve wood utilization and increase the use of wood bridges.

Library ID: 11-0018

Title: **Rural Bridges: An Assessment Based Upon the National Bridge Inventory**

Author: Nicholas Marathon

Publisher: USDA Office of Transportation

Year Published: 1989 Number of Pages: 26

This analysis focusing on various characteristics of rural highway bridges, is derived from the most comprehensive single source of data concerning the Nation's highway bridges — the National Bridge Inventory (NBI).

Library ID: 11-0019

Title: **Engineered Wood for Transportation Structures Workshop Record**

Author: WVU-CFC

Publisher: WVU-CFC

Year Published: 1994 Number of Pages: 70

This record consists of reports on workshops that were held to discuss the opportunities and obstacles facing engineered wood in 5 applications - bridge superstructures, guide rails and posts, noise/sight barriers and formwork, geotechnical structures, and repair and rehabilitation.

Library ID: 11-0020

Title: **Research Accomplishments for Wood Transportation Structures Based on a National Research Need Assessment**

Author: Michael A. Ritter, Sheila Rimal Duwadi

Publisher: USDA Forest Service, FPL

Year Published: 1998 Number of Pages: 30

In 1991, the USDA Forest Service, Forest Products Laboratory (FPL) and the Federal Highway Administration (FHwA) formed a joint cooperative research program for wood transportation structures. Development and execution of this program was based on a national assessment of research needs and priorities. In the 5 years since completion of the research needs assessment, significant research has been completed or is ongoing for wood transportation structures. This publication provides a summary of the research accomplishments of the joint FPL-FHwA research program for wood transportation structures.

Library ID: 11-0021

Title: **Bridge Scour Evaluation: Screening, Analysis, and Countermeasures**

Author: John Kattell, Merv Eriksson

Publisher: USDA Forest Service, San Dimas Technology and Development Center

Year Published: 1998 Number of Pages: 20

This publication describes the USDA Forest Service's Scour Evaluation Program including screening, analysis, and countermeasures for damaged structures.

Library ID: 11-0025

Title: **Identifying and Preserving Historic Bridges**

Authors: Merv Eriksson, C. Milo McLeod, Dan Gard

Publisher: USDA Forest Service, Missoula Technology and Development Center

Year Published: 2000 Number of Pages: 90

The publication has been written to improve communication and streamline coordination between engineers and heritage resource specialists and to effectively and efficiently identify and manage Forest Service historic bridges. This publication will serve as a guide and information source for evaluating bridges for potential National Register of Historic Places (NRHP) listing and preserving and maintaining significant historic bridges.

Section 12 — Surfacing

Library ID: 12-0001

Title: **Surfacing Treated Decks with Bituminous Materials**

Author: Larry Bruesch, Adrian Pelzner

Publisher: USDA Forest Service, FPL

Year Published: 1976 Number of Pages: 3

A key requirement for an adequate timber bridge is an economical, serviceable wearing surface. Past experience has shown that requirement to be a major maintenance problem with all of the common types used: timber running plank; steel plate; aggregates; and bituminous materials. Of these types, the latter seems to have the most promise; however, satisfactory performance has been limited for several reasons. One of the major problems, differential deflection between deck lams or planks, can be eliminated by using the dowelled glue-lam deck panels. The other major problem, a satisfactory bituminous material properly bonded to the treated timber, is the subject of this discussion.

Section 12 — Surfacing *cont.*

Library ID: 12-0002

Title: **Guidelines for Design, Installation, and Maintenance of a Waterproof Wearing Surface for Timber Bridge Decks**

Author: Richard E. Weyers, Joseph R. Loferski, J. Daniel Dolan, John E. Haramis, Joseph H. Howard, Lola Hislop

Publisher: USDA Forest Service, FPL

Year Published: 2001 Number of Pages: 15

URL: http://www.fpl.fs.fed.us/documnts/fplgtr/fplgtr123.pdf

To enhance long-term timber bridge performance, timber material must be protected from moisture. Wearing surfaces made of asphalt pavement with and without a waterproof membrane have been used to provide protection from moisture on timber decks. To improve the performance of a wearing surface, it must be designed, installed, and maintained properly. This document provides guidelines for the proper design, installation, and maintenance of a waterproof wearing surface for timber bridge decks.

Library ID: 12-0003

Title: **Considerations When Paving Treating Timber Bridge Decks**

Authors: Merv Eriksson

Publisher: IABSE Conference—Innovative Wooden Structures and Bridges

Year Published: 2001 Number of Pages: 6

Increased awareness of the efficiencies of timber bridges has resulted in a surge of treated timber bridge construction in the United States. Asphalt pavement problems have appeared due to deck flexibility and/or shrinkage, excessive treatment, and treatment/ paving system incompatibility. This paper discusses ways to economically ensure long term pavement performance, while minimizing negative environmental impacts.

Section 13 — Financial Information

Library ID: 13-0003

Title: **A Hypothetical Business and Financial Plan of the Production of Glulam Lumber for Timber Bridge Construction**

Author: Dwight R. McCurdy, John E. Phelps

Publisher: Department of Forestry, Southern Illinois University

Year Published: 1993 Number of Pages: 51

This business and financial plan is prepared as a model and a basis for business management discussion and is not intended to illustrate either effective or ineffective administrative or technical practices.

Section 14 — Crossings Newsletter

Crossings is the quarterly newsletter of the Wood In Transportation Program. You can view and download past issues of *Crossings* from our website at www.fs.fed.us/na/wit. If you would like to receive *Crossings* on a quarterly basis, please check box 01-0004 on the order form.

Library ID: 15-0001

Title: **Baileyville Demonstration Timber Bridge, Centre County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/centre_county_baileyville.pdf

This factsheet provides information on a demonstration bridge design that consists of glued-laminated timber stringers and a transverse glued-laminated timber deck. Wood species is red oak. Preservative treatment is creosote.

Library ID: 15-0002

Title: **Brookston Road Demonstration Timber Bridge, Forest County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/forest~1.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber/steel composite bridge. Wood species is red oak. Preservative treatment is creosote.

Library ID: 15-0003

Title: **County Timber Bridge #3, Green County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/greene_county_na-28-89.pdf

This factsheet provides information on a demonstration timber bridge project. The design consists of steel stringers and a transverse glued-laminated deck. Wood species is red maple. Preservative treatment is creosote.

Library ID: 15-0004

Title: **Dutch Hill Road Timber Bridge, Crawford County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/crawford_county_dutch_hill_road.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is red maple. Preservative treatment is creosote.

Library ID: 15-0005

Title: **Millcross Road Timber Bridge, Lancaster County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/lancaster_county_millcross_road.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is Douglas-fir. Preservative treatment is creosote.

Library ID: 15-0006

Title: **Trough Creek State Park Timber Bridge, Huntingdon County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/huntingdon_county_trough_creek2.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a glued-laminated arch and a transverse glued-laminated deck. Wood species are southern pine and red maple. Preservative treatment is pentachlorophenol.

Library ID: 15-0007

Title: **County Bridge 134, Perry County, Indiana**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/in/perry_county_bridge_134.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated T bridge. Wood species are southern pine and red oak. Preservative treatment is creosote.

Library ID: 15-0008

Title: **Wolf Run Road Timber Bridge, Jefferson County, Indiana**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/in/jefferson_county_wolf_run.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is red oak. Preservative treatment is creosote.

Library ID: 15-0009

Title: **Emily Lake Road Box Culvert, Houghton County, Michigan**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mi/emily_lake.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a box culvert. Wood species is hemlock. Preservative treatment is chromated copper arsenate.

Library ID: 15-0010

Title: **Graves Crossing Timber Bridge, Antrim County, Michigan**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mi/graves_crossing.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is red pine. Preservative treatment is chromated copper arsenate.

Library ID: 15-0011

Title: **Main Black Timber Bridge, Montmorency County, Michigan**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mi/main_black.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated boxbeam bridge. Wood species are southern pine and red pine. Preservative treatment is creosote.

Library ID: 15-0012

Title: **Old Vanderbilt Road Timber Bridge, Otsego County, Michigan**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mi/old_vanderbilt.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is red pine. Preservative treatment is creosote.

Library ID: 15-0013

Title: **Portable Logging Demonstration Timber Bridge, Michigan**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mi/portable.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber portable bridge. Wood species is red pine. Preservative treatment is chromated copper arsenate.

Library ID: 15-0014

Title: **Huntsman Road Timber Bridge, Richland County, Ohio**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/oh/richland_county_huntsman_road.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is southern pine. Preservative treatment is alkaline copper quat.

Library ID: 15-0015

Title: **Meigsville Township 150 Timber Bridge, Morgan County, Ohio**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/oh/morgan_cty_meigsville_twp150.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a box culvert. Wood species is southern pine. Preservative treatment is chromated copper arsenate.

Library ID: 15-0016

Title: **Local Timber Bridge No. 1-5, Allegany County, New York**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/ny/allegany_county_local_bridge_1-5.pdf

This factsheet provides information on a demonstration timber bridge project. The type consists of steel stringers supporting a transverse glued-laminated deck. Wood species are beech and hickory. Preservative treatment is pentachlorophenol.

Library ID: 15-0017

Title: **Local Timber Bridge No. 5-1, Allegany County, New York**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/ny/allegany_county_local_bridge_5-1.pdf

This factsheet provides information on a demonstration timber bridge project. The type consists of steel stringers with a stress-laminated sawn lumber deck. Wood species are beech and hickory. Preservative treatment is pentachlorophenol.

Library ID: 15-0018

Title: **Local Timber Bridge No. 25-8, Allegany County, New York**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/ny/allegany_county_local_bridge_25_8.pdf

This factsheet provides information on a demonstration timber bridge project. The type consists of bolted n-frame units. Wood species include mixed hardwoods including red maple, hickory, and beech. Preservative treatment is pentachlorophenol.

Library ID: 15-0019

Title: **Nelson Slough Timber Bridge, Skagway, Alaska**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/ak/skagway_nelson_slough.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is Alaska yellow-cedar. No preservative treatment is required for Alaska yellow-cedar.

Library ID: 15-0020

Title: **East Fork Rosebud Creek Timber Bridge, Carbon County, Montana**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mt/east_fork_rosebud_creek.pdf

This factsheet provides information on a demonstration timber bridge project. The type is glued-laminated timber stringers supporting a transverse glued-laminated deck. Wood species is Douglas-fir. Preservative treatment is creosote.

Library ID: 15-0021

Title: **Timber Bridge No. 1, Coshocton County, Ohio**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/oh/coshocton_county_bridge_1.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is southern pine. Preservative treatment is creosote.

Library ID: 15-0022

Title: **Oak Drive Timber Bridge, Stark County, Ohio**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/oh/stark_county_oak_drive.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated t-beam with southern pine glulam beams and sawn northern red oak flange. Wood species are southern pine and northern red oak. Preservative treatment is creosote.

Library ID: 15-0023

Title: **Kepler-Bradley Lakes Timber Bridge, Matanuska-Susitna Borough, Alaska**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/ak/kepler-bradley_bridge_mat-su_borough.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is Alaska white spruce. Preservative treatment is copper sulfate and sodium fluoride using double diffusion treatment process.

Library ID: 15-0024

Title: **Little Bitterroot River Timber Bridge, Sanders County, Montana**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mt/sanders_county_little_bitterroot_river.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is coastal Douglas-fir. Preservative treatment is copper naphthenate (2% copper).

Library ID: 15-0025

Title: **Lynn Run Trail Bridge #1, Westmoreland County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/westmorland_county_lynn_run.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a king post truss design. Wood species is hemlock. Preservative treatment is chromated copper arsenate.

Library ID: 15-0026

Title: **Lynn Run Trail Bridge #2, Westmoreland County, Pennsylvania**

Author: NWITIC and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1999 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/westmorland_county_lynn_run2.pdf

This factsheet provides information on a demonstration timber bridge project. The type is a king post truss design. Wood species is hemlock. Preservative treatment is chromated copper arsenate.

Library ID: 15-0027

Title: **American Farmland Trust Timber Bridge, Franklin County, Pennsylvania**

Authors: National Wood In Transportation Information Center and American Farmland Trust

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/pa/aft_mt_cove_farm.pdf

This factsheet provides information on a demonstration timber bridge design that consists of glued-laminated timber stringers and a transverse glued-laminated timber deck. Wood species of the stringers are southern pine and red maple. Wood species of the deck is southern pine. Preservative treatment is creosote.

Library ID: 15-0028

Title: **McCurdy Road Timber Bridge, Richland County, Ohio**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/oh/richland_county_mccurdy_road.pdf

This factsheet provides information on a demonstration bridge design that consists of stress-laminated southern pine lumber treated with ACQ. The Richland County engineer's staff fabricated and installed the bridge.

Library ID: 15-0029

Title: **Flint Creek Timber Bridge, Granite County, Montana**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/mt/flint_creek_granite_county.pdf

This factsheet provides information on a demonstration bridge design that consists of glued-laminated wood beams with a transverse glued-laminated wood deck. Timber was coastal Douglas-fir treated with pentachlorophenol in heavy oil.

Library ID: 15-0030

Title: **Improving Access to Rural Residential Homes in West Virginia**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2000 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/wv/WIT-15-0030.pdf

The factsheet highlights WIT commercialization activities in West Virginia in 1999 and 2000. Twenty timber decks supported by steel stringers bridges will eventually be built as a result of two commercialization projects. The timber decks are southern pine and/or local hardwoods treated with CCA.

Library ID: 15-0031

Title: **High Point Road Timber Bridge, Bay County, Florida**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 2

URL: http://www.fs.fed.us/na/wit/pdf/bridge_fact_sheets/fl/bay_county.pdf

This factsheet highlights a glulam timber bridge designed and constructed in Bay County, Florida. This bridge was part of a "Commercialization Project" funded in 1997 for $50,000. The design incorporated the use of standard drawings included in publication: WIT-02-0060 Standard Plans for Timber Bridge Superstructures.

Library ID: 15-0032

Title: **Petty Creek Bridge, Missoula County, Montana**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 4

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated T-beams comprised of laminated veneer lumber. Wood species is coastal Douglas-fir. Preservative treatment is pentachlorophenol.

Library ID: 15-0033

Title: **Sunset Hill Road Bridge, Missoula County, Montana**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 4

This factsheet provides information on a demonstration timber bridge project. The type is a series of longitudinal glued-laminated deck panels. Wood species is coastal Douglas-fir. Preservative treatment is pentachlorophenol.

Library ID: 15-0034

Title: **Provo River Pedestrian Covered Bridge**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 4

The factsheet provides information about a demonstration pedestrian timber bridge near Heber City, Utah. The bridge design incorporates glulam/fiber reinforced polymer beams with glulam deck panels. The bridge also includes a cover supported by timber framing. The bridge is part of a non-motorized trail connecting the towns of Heber City and Midway as well as connecting to the Soldier Hollow Nordic Skiing Venue for the 2002 Winter Olympics.

Section 15 — Demonstration Project Factsheets *cont.*

Library ID: 15-0035

Title: **Hoblitt Lane/West Fork Bass Creek Bridge, Ravalli County, Montana**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 4

This factsheet provides information on a demonstration timber bridge project. The type is a stress-laminated sawn lumber bridge. Wood species is coastal Douglas-fir. Preservative treatment is pentachlorophenol.

Library ID: 15-0036

Title: **Timber Bridge Commercialization Project, Yellowstone County, Montana**

Authors: National Wood In Transportation Information Center and Partners

Publisher: USDA Forest Service, NA-S&PF

Year Published: 2001 Number of Pages: 4

This factsheet highlights a WIT commercialization project that resulted in the design and construction of three glued-laminated timber stringers with transverse glued-laminated deck panel bridges. Wood species is coastal Douglas-fir. Preservative treatment is creosote.

Section 97 — Videos

Library ID: 97-0014

Title: **Modern Timber Bridges: An Attractive Option**

Author: Alabama Forestry Commission in cooperation with the USDA Forest Service

Publisher: Alabama Forestry Commission

Year Published: Number of Minutes: 16

This video looks at modern timber bridges as an attractive option. It includes statistics on structurally deficient bridges, reasons for choosing modern timber bridges, design standards, components of the bridges, and gives definitions of glued-laminated (glulam) and stressed-laminated bridges. There is also construction of a glulam bridge and a discussion on the advantage of the modern timber bridge.

Library ID: 97-0026

Title: **Prefabricated Timber Bridge Deck Panels**

Author: John Smolen

Publisher: USDA Forest Service, NA-S&PF

Year Published: 1998 Number of Minutes: 11

This video illustrates a relatively low cost method for fabrication of timber decks over steel girders using methods developed by John Smolen, County Engineer for Ashtabula County, Ohio.

Additional Sources of Information

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO List of Publications

Contact: American Association of State Highway &Transportation Officials
444 N. Capitol St. N.W., Suite 249
Washington, DC 20001
Telephone: (202) 624-5800
FAX: (202) 624-5806
Internet: www.aashto.org

American Forest and Paper Association – American Wood Council

National Design Specifications for Wood Construction

Structural Lumber/Glued-Laminated Timber/Timber Piles/Connections

Contact: American Forest and Paper Association
1111 19th Street, N.W., Suite 800
Washington, DC 20036
Telephone: (202) 463-2766 or (800) 890-7732
FAX: (202) 463-2791
Internet: www.awc.org

American Institute of Timber Construction (AITC)

Standard Specifications for Structural Glued Laminated Timber

American National Standard for Wood Products – Structural Glued Laminated Timber

Contact: American Institute of Timber Construction
7012 S. Revere Parkway, Suite 140
Englewood, CO 80112
Telephone: (303) 792-9559
FAX: (303) 792-0669
Internet: www.aitc-glulam.org

APA – The Engineered Wood Association

Glued Laminated Beam Design Tables - Data Files

Glulam Connection Details

Preservative Treatment of Glued Laminated Timber

Substitution of Glulam Beams for Steel or Solid-Sawn Lumber – Data File

Contact: American Plywood Association – The Engineered Wood Association
7011 South 19th Street
PO Box 11700
Tacoma, WA 98411-0700
Telephone: (253) 565-6600
FAX: (253) 565-7265
Internet: www.apawood.org

American Wood Preservers Institute

Answers to Often-Asked Questions about Treated Wood

Contact: American Wood Preservers Institute
2750 Prosperity Avenue, Suite 550
Fairfax, VA 22031-4312
Telephone: (703) 204-0500 or (800) 356-2974
FAX: (703) 204-4610
Internet: www.preservedwood.com

Additional Sources of Information *cont.*

American Wood-Preservers' Association

American Wood-Preservers' Association Standards

Contact: American Wood-Preservers' Association
PO Box 5690
Granbury, TX 76049-0690
Telephone: (817) 326-6300
FAX: (817) 326-6306
Internet: www.awpa.com

Asphalt Institute

Asphalt in Pavement Maintenance

Asphalt Overlays for Highway and Street Rehabilitation – Manual Series No. 17

Contact: Asphalt Institute
PO Box 14052
Lexington, KY 40512-4052
Telephone: (859) 288-4960
FAX: (859) 288-4999
Internet: www.asphaltinstitute.org

Federal Highway Administration

A Guide to Federal-Aid Programs, Projects, and Other Uses of Highway Funds. Publication No. FWHA-PD-92-018

Contact: Federal Highway Administration
Office of Engineering, HNG-10
400 7th Street, S.W., Room 3134
Washington, DC 20590
Telephone: (202) 366-0450
FAX: (202) 366-3988
Internet: www.fhwa.dot.gov/pubstats.html

Forest Products Society

Wood Handbook: Wood as an Engineering Material

Contact: Forest Products Society
2801 Marshall Court
Madison, WI 53705-2295
Telephone: (608) 231-1361
FAX: (608) 231-2152
Internet: www.forestprod.org

National Timber Piling Council, Inc.

Technical Guidelines for Construction with Treated Round Timber Piling

Contact: American Wood Preservers Institute
2750 Prosperity Avenue, Suite 550
Fairfax, VA 22031-4312
Telephone: (703) 204-0500 or (800) 356-2974
FAX: (703) 204-4610
Internet: www.preservedwood.com/pil/pil.html

Pennsylvania Department of Transportation

Publication 6M: BLC–560M Series — Standards for Hardwood Glulam Timber Bridge Design

Hybrid Timber Bridge Instructional Program, on CD-ROM

Contact: PENNDOT, Bureau of Municipal Services
Attn: Alvin Black
PO Box 8211
Harrisburg, PA 17105-8211
Telephone: (717) 787-2183
E-mail: PennDOT_BoMS@dot.state.pa.us
Internet: www.dot.state.pa.us

Transportation Research Board / National Research Council

Contact: Transportation Research Board / National Research Council
2101 Constitution Avenue, N.W.
Washington, DC 20418
Telephone: (202) 334-2933
FAX: (202) 334-2003
Internet: www.trb.org

USDA Forest Service, Missoula Technology and Development Center

Lead-Based Paint: Abatement Alternative for Bridges

Contact: USDA Forest Service, Missoula Technology and Development Center
Building 1, Fort Missoula
Missoula, MT 59804
Telephone: (406) 329-3900
FAX: (406) 329-3719
Internet: www.fs.fed.us/eng/techdev/mtdc.htm

USDA Forest Service, San Dimas Technology and Development Center

Bridge Scour Evaluation: Screening, Analysis, and Countermeasures

Contact: USDA Forest Service, San Dimas Technology and Development Center
444 E. Bonita Avenue
San Dimas, CA 91773
Telephone: (909) 599-1267
FAX: (909) 592-2309
Internet: www.fs.fed.us/eng/techdev/sdtdc.htm

Western Wood Preservers Institute/Canadian Institute of Treated Wood

Best Management Practices for the Use of Treated Wood in Aquatic Environments

Contact: Western Wood Preservers Institute
7017 N.E. Highway 99, Suite 108
Vancouver, WA 98665
Telephone: (360) 693-9958 or (800) 729-WOOD
FAX: (360) 693-9967
E-mail: info@wwpinstitute.org
Internet: www.wwpinstitute.org
or
Canadian Institute of Treated Wood
200-2430 Don Reid Drive
Ottawa, ON K1H 8P5
Canada
Telephone: (613) 737-4337
FAX: (613) 247-0540

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☐ 01-0036 ☐ 01-0037

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Website at: http://www.fs.fed.us/na/wit

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